General Science Quarterly

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Vol. IV MAY 1920 No. 4

Tests in General Science

PAUL A. MAXWELL, Avalon, Penna.

I

The subject "Standard Tests" has been of the utmost significance in the minds of educators for some time. Accordingly the educational field has been flooded with tests in the various subjects. Many tests in writing, spelling, history, mathematics, English, etc. have appeared. Under these conditions it is surprising to note the scarcity of science tests. Outside the field of general science four tests have appeared; two information tests in physics by Starch and Chapman respectively; a problem and formula test in science by Jones; and an information test of high school science by E. R. Downing.

The first test to appear in general science was a "Range of Information Test in General Science" by G. M. Ruch, University of Oregon, which was published in the GENERAL SCIENCE QUARTERLY, November, 1919. I know of no other test in this field except my own "Standard Test of Information and Thought in General Science." A description of the latter together with the preliminary work of standardization, follows.

II

In preparing a standard test in general science I felt that I should be influenced by the aims of science teaching, which are not only to create a fund of knowledge, but also to develop the habit of scientific thinking. I have therefor provided a set of questions to test the pupil's range of information and also a list of problems to test his ability to think or reason scientifically both in and out of the field of science. I have made these questions the basis of a preliminary study before attacking the work of standardization.

The *Information Test* consists of sixty-five questions to which the answers are words, numbers or simple expressions and to each of which there is usually only one acceptable answer. While no test is broad enough to cover the entire field of a subject, yet I have varied the subject matter involved in the questions in such a way that they represent the range of imformation presented in the most used text books.

In the *Thought or Reason Test* there are twenty problems which involve either inductive or deductive reasoning. The correct answer to each may be "yes" or "no", or in case the answer is not known, "I do not know." Some of the problems involve science material while others are merely concerned with common superstitions or beliefs arrived at through unscientific methods of thinking.

The adaptability of this test to standardization is readily apparent. The simplicity and uniformity of answers is of utmost worth in this respect. Grading may also be done with the greatest possible speed.

III

In order to have a sound basis for revision before standardizing the tests I have given them to two hundred ten pupils in three high schools; Schenley High School, Pittsburgh; Avalon High School; and Sewickley High School. All the pupils had had one year of general science. From these test papers I first determined the approximate value of each question based upon the frequency with which it was answered. I was also able to tell the time necessary to complete the test. Then, merely for the pedagogical value, I determined the relative ability of boys and girls both as to information and reasoning, and also the correlation of speed to accuracy.

In the revision of the test I expect to drop questions which admit too varied answers and those which can not be adjusted to a smooth scale. I expect to give the test to several thousand pupils this year.

IV

Following are the two sets of questions with the answers and the number of times each question was answered correctly by the two hundred ten pupils. The questions are preceded by the heading and directions as they were actually given.

Information Test

FIRST YEAR SCIENCE

City .....State ..... Date .....
Name .....Age ..... Grade .....
Time required to complete test.....

Directions.

The following questions are to be answered by a single word (in a few cases two words) or by a number. Examples:

1. What is the lightest element?.....
2. What is the speed of light in miles per second? .....

The word "hydrogen" should be written in the space following the first question. The number "186,000" should be written in the space following the second question.

Questions	Answers	Answered Correctly
1. What is the best method for purifying water?	Distillation	108
2. In how many states may matter exist? ...	Three	128
3. What is the disease most often spread by drinking water?	Typhoid Fever	152
4. What gas do plants extract from the air they breathe?	Carbon dioxide	144
5. Of what raw material are bricks usually made?	clay	151
6. What class of substances turns blue litmus red?	acids	938
7. What are substances that do not conduct electricity called?	insulators	161
8. What substance is formed when hydrogen burns?	water	556
9. At what temperature, Centigrade, does water boil?	100 degrees	74
10. What is the speed of sound through air in feet per second?	1100 or 1080	33
11. What force causes water to rise through the soil?	capillarity	22
12. What element of the air is fixed in the soil by bacteria?	nitrogen	48
13. What part of the human eye functions like the plate or film of a camera?	retina	49
14. What class of substances counteracts the action of acids?	bases or alkalies	90
15. What organ of a flower is usually found at the very center?	pistil	118
16. For what is Marconi famous?	wireless telegraphy	127
17. How many pounds does a cubic foot of water weight?	62.4	69
18. What characteristics of a sound wave determines the intensity of the sound?	amplitude	0
19. Through what organ does water enter a plant?	root	131
20. What do carbohydrates produce for the body?	heat or energy	106
21. What device is used for measuring the intensity of a light?	Photometer	1
22. What fibre makes the best clothing for cold climates	wool	183

23.	What substance is produced by the stamens of a flower?	pollen	131
24.	Who invented the phonograph?	Edison	190
25.	How many grams does a cubic centimeter of water weigh?	one	62
26.	What per cent of the air, by volume, is oxygen?	21	23
27.	What substance is commonly used to correct acidity of the soil?	lime	72
28.	To what micro-organism is decay due?	bacteria	72
29.	What kind of objects will not allow light to pass through them?	opaque	108
30.	In shovelling coal what principle is illustreated when the coal leaves the shovel?	inertia	41
31.	What is the structure found at the top of a pistil?	stigma	32
32.	Against what disease is vaccination a preventative measure?	smallpox	141
33.	How much heat is required to raise the temperature of one gram of water one degree, Centigrade?	one calorie	37
34.	What element is taken from the air by a burning substance?	oxygen	114
35.	What force causes soil water to enter the root of a plant?	osmosis	7
36.	What is the raw material necessary for fermentation?	sugar	13
37.	What is the name of the angle at which a ray of light strikes a reflecting surface?	incidence	63
38.	To what class of simple machines does a pair of scissors belong?	levers	106
39.	What is the structure found at the top of a stamen	anther	35
40.	Who discovered the antitoxin for hydrophobia?	Pasteur	23
41.	What instrument is used to measure atmospheric pressure?	barometer	145
42.	What is the unit structure of which all living things are composed?	cell	64
43.	In what organ of a plant is starch made?	leaf	45
44.	What is the source of all energy upon the earth?	sun	77
45.	How many electrodes are there in an electric cell?	two	81
46.	What force causes a compass needle to point north?	magnetism	100
47.	What is the process called when a sperm cell unites with an egg?	fertilization	50
48.	What is the atmospheric pressure at sea level in pounds per square inch?	fifteen	92
40.	What substance present in the air determines humidity?	water	81
50.	What causes the ocean tides?	moon	122
51.	What method of heat distribution is employed in a hot air furnace?	convection	39
52.	What is the rotating coil of a motor called?	armature	53
53.	Who was the father of the theory of evolution?	Darwin	86
54.	What is the line on a weather map that joins points of equal temperature?	isotherm	14

55.	What plant fibre is most used in making cloth?	cotton	162
56.	From what mineral is coke made?	coal	187
57.	What liquid is the best solvent?	water	93
58.	What is used to test for the presence of carbon dioxide?	lime water	31
50.	What form of energy makes objects visible?	light	76
60.	What kind of energy does an electric dynamo produce?	electricity	80
61.	From what organic substance is soap made?	fat	110
62.	What form of energy is readily changed into magnetism?	electricity	87
63.	What insect spreads malaria?	mosquito	141
64.	What kind of enegy does an electric motor produce?	mechanical	58
65.	To which of the three great classes of food does sugar belong?	carbohydrates	111

Test of Reasoning

FIRST YEAR SCIENCE

Directions.

This is a test of your ability to think and reason scientifically. You are given certain information and then asked a question about it. You may answer either "yes" or "no." If you do not know which of these is correct or if insufficient information is given, answer "I do not know." Indicate your answer by a check as in the following example to which "yes" is the correct answer.

Example. An oxide is a compound consisting of oxygen and some one other element. When the element hydrogen burns it unites with oxygen to form water. Is water an oxide?

Yes ✓ No I do not know

Problems	Answers	Times Answered Correctly
1. Matter is the only thing in the universe that possesses weight. I heated a vessel containing copper to a very high temperature. Before heating it weighed 21 grams. After heating it weighed 22 grams. Was any matter added to the vessel when heated?	Yes	109
2. The average salary of college graduates in the United States is $1,000 a year more than the average salary of adults who are not college graduates. Does a college education increase one's earning power?	I do not know	7
3. A gram of anthracite coal produces 8,000 calories of heat. A gram of bituminous coal produces 6,000 calories. When anthracite coal is selling at $8 a ton and bituminous at $6, is it more economical to buy bituminous coal than anthracite?	No	164
4. An element is a substance that cannot be decomposed or broken up into substances nor		

can it be made by the union of other substances. I added a piece of the element zinc to a liquid. The element hydrogen came from the mixture. Did the liquid contain hydrogen?	Yes	120
5. George Washington, Abraham Lincoln, Ulysses S. Grant, Theodore Roosevelt and many other great men were raised in the country. Are people raised in the country apt to be more successful than people raised in the city?	I do not know	24
6. Sunshine is known to purify the air while germs bred fastest in the dark. Is the air more healthful indoors than outdoors at night?	No	135
7. When two bottles are filled with any two gases, one gas in each bottle, and held mouth to mouth one above the other, the gases will soon mix thoroughly, half of each being found in each bottle. Is the air near the ceiling of a room as pure for breathing as the air near the floor?	Yes	55
8. In four of the largest cities of the United States the champion basketball teams are made up entirely of Jews. In not one large city is the champion basketball team made up entirely of Irishmen. Are Jews better basketball players than Irishmen?	I do not know	60
9. By comparing the grades of 300 high school boys and 300 high school girls it was found that the boys' grades were on the average 12% higher than the girls' in mathematics. Have boys more ability than girls in mathematics?	I do not know	27
10. A solution of a base becomes red when phenolphthalein is added to it. No other solutions are affected in this way. When phenolphthalein is added to a solution of sodium carbonate the solution turns red. Is there a base present?	Yes	147
11. In ten colleges it was found that 70% of the letter men in football did not use tobacco while in training. Is tobacco injurious to an athlete?	I do not know	2
12. A chemical compound is a substance composed of two or more simpler substances called elements. When mercuric oxide is heated in a test tube the element oxygen is given off and the element mercury is left. Is mercuric oxide a chemical compound?	Yes	156
13. By mixing air with natural gas before burning, the flame is reduced in size and changed from yellow to blue. Often when gas is scarce, stoves that usually produce a large yellow flame produce only a small yellow flame. Has air been mixed with the gas?	No	115

14. Two years ago I bought an "A" stove for my room. Many times during the winter of that year I was unable to get my room comfortably warm. The following year I used a "B" stove and always had my room warm. Was the "B" stove a better heater than the "A" stove?	I do not know	39
15. A soldier who fought in the recent war said: "We took one of our prisoners and hung him up by the wrists. Any of our soldiers who came by would take a punch at him. He was soon pounded to a pulp." Was I talking to an American soldier?	I do not know	48
16. Other conditions being the same, water evaporates from a pond more rapidly on a windy day than on a calm day. When water evaporates it absorbs heat from the things it is in contact with. Does it take a lower temperature of the atmosphere to freeze a pond on a calm day than on a windy day?	Yes	117
17. For ten years a certain baseball club has not won a game played on "Friday the thirteenth." Should that club refuse to schedule games for Fridays that come on the thirteenth?	No	98
18. There were two farmers. One always planted his cucumber seed in the light of the moon. His vines produced many blossoms but little fruit. The other planted his seed in the dark of the moon and reaped fine crops of cucumbers. Is it best to plant cucumber seed in the light of the moon?	No	150
19. I placed my hand upon a piece of steel. It felt cold. I placed it upon a woolen blanket. It felt warm. Was the steel at a lower temperature than the blanket?	I do not know	13
20. Of all successful lawyers 99% are men and 1% are women. Have women the ability to succeed at law?	Yes	112

V

I believe that the idea is prevalent that boys show more ability in science work than girls. As shown in the table below, my results offer little evidence in favor of this idea. I have found greater variability in the boys than in the girls, but the medians are almost identical.

There has been, in general, a positive correlation of speed to accuracy. I found this correlation by the "Difference in Rank" method.

Table of Results

	Pittsburgh		Avalon		Sewickley	
	Girls	Boys.	Girls	Boys.	Girls	Boys
Number of pupils	37	107	21	24	6	15
Information Test						
Score:						
Median	27	28	18	23	30	32
Probable Error	5	7	3.5	7	5	6
Variability Coefficient	.18	.25	.19	.30	.17	.19
Speed:						
Median (minutes)	35	30	15	14		
Probable Errar	5	6.5	1	2		
Variability Coefficient	.14	.46	.07	.14		
Speed and Accuracy Correlation	.29	.39	-.09	-.14		
Reasoning Test						
Score:						
Median	9	9	8	7	8	9
Probable Error	1.5	1.5	1.5	1	1	3
Variability Coefficient	.17	.17	.19	.14	.13	.33
Speed:						
Median (minutes)	15	15	9	8		
Probable Error	3	4	1	1		
Variability Coefficient	.20	.27	.11	.13		
Speed and Accuracy Correlation	.18	-.06	.22	.44		

Comparison of Text Book rule in General Science

GILBERT H. TRAFTON, State Normal School, Mankato, Minn.

The text book has been and will continue to be a very important factor in the teaching of any subject in secondary schools. In the great majority of schools the teacher is so burdened with a multiplicity of subjects that she has neither the time nor the ability to organize independent courses. In many cases it would be out of the question for teachers to carry on their courses without texts. Since textbooks are so widely used, a study of them will give a fair notion of the kind of work that is being done in any subject thruout the schools of the country.

A study of textbooks in general science is of special interest at this time because the general science movement has had such a remarkable growth in recent years. Corresponding closely with this growth a great number of textbooks have appeared. For this comparative study the writer has taken all the texts that have come to his attention, not including laboratory manuals. This list numbers 20; as three of these are revised editions of former publications, the study includes the texts of 17 authors. Following is the list.

BARBER, *First Course in General Science.* Henry Holt Co.
BROWNELL, *General Science.* Blakiston Co.
CALDWELL AND EIKENBERRY, *General Science.* Ginn Co.
CLARK, *An Introduction to Science.* American Book Co.
COULTER, *Elementary Science.* Scribners.
ELHUFF, *General Science.* D. C. Heath Co.
FALL, *Science for Beginners.* World Book Co.
HESSLER, *The First Year of Science.* B. H. Sanborn Co.
HODGDON, *Elementary General Science.* Hinds, Hayden, and Eldridge.
LAKE, *General Science.* Silver Burdett Co.
PATTERSON, *Studies in Science.* Row, Peterson Co.
PEASE, *General Science.* C. E. Merrill Co.
SMITH AND JEWETT, *Introduction to the Study of Science.* Macmillan Co.
SNYDER, *Everyday Science.* Allyn and Bacon.
TRAFTON, *Science of Home and Community.* Macmillan Co.
VAN BUSKIRK AND SMITH, *The Science of Everyday Life,* Houghton Mifflin.
WECKEL AND THALMAN, *A Year in Science.* Row, Peterson.

A study of the different titles used is of some interest as suggesting the general viewpoint of the author, but no attempt will be made to discuss this matter here.

The following table shows the dates of publications and the number each year.

1912 —— 1	1917 —— 3
1914 —— 3	1918 —— 4
1915 —— 2	1919 —— 4
1916 —— 3	

As regards the number of pages and illustrations, the pages run from 290 to 620, and the illustrations from 86 to 395.

The discussion of the aims of teaching general science is so brief in the various texts that no satisfactory study of this aspect could be made. Following, however, are some of the aims which are more frequently mentioned.

Foundation for later science studies.

Scientific study of environment.

To produce a scientific attitude.

To stimulate thinking.

To afford culture.

Chief attention has been given in this study to the matters of content and organization. In order to compare the texts from the standpoint of content, the writer examined each book to ascertain the number of pages that were devoted to each of the sciences. The total number of pages for all the texts combined and the percent devoted to each science are shown in the following table.

Science	Number of pages	Per Cent of pages.
Physics	2412	33.5
Hygiene	1307	18.2
Physical Geography	1047	14.6
Biology	934	13.
Chemistry	743	10.3
Agriculture	541	7.5
Astronomy	207	2.9
Total	7191	100.

It is seen that the physical topics predominate, occupying nearly twice as much space as the next highest. The seven sciences may be classed into 3 groups according to the space accorded them: the major group (physics and hygiene) which occupies about 52 per cent of the space; the medium group (physical geography, biology, and chemistry) which occupies about 38 per cent of the space; and the minor group (agriculture and astronomy), which occupies about 10 per cent of the space.

Every text includes some topics in physics, chemistry, hygiene, biology, and physical geography. 76% include some agriculture, and 59% include some astronomy. 12 texts devoted the most space to physics, 2 to hygiene, 2 to physical geography, and 1 to agriculture.

The distribution according to sciences is shown below in the curve. This average curve must not be taken as an ideal of what *should be* taught. It must be taken simply for what it is, the average of 17 text books. It makes, however, an interesting basis for comparison. It may be suggestive as a check in preventing a teacher from going to the extremes of putting either too much or too little stress on some one science.

In order to show how much variation there is in the text books, two other curves have been given showing the distribution of space in two texts which strongly emphasize one science. It is interesting to note that in revisions that have been made of both these texts, the emphasis placed on these two sciences has been greatly reduced, and a distribution is found which more nearly approaches the average.

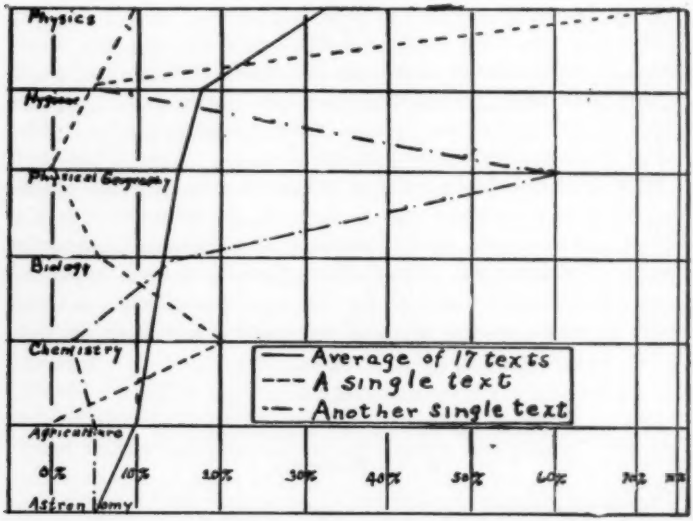
From the standpoint of content the texts may be divided into 3 groups. In one group are those that are based on one

science. The rest of the sciences are merely incidental. This is really a modified special science.

In a second group are those which include something of every science, without apparent reference to their relative value, with the evident intention of being impartial.

In a third group are those which lay major stress on two or more sciences and show an attempt to evaluate them and to select them from the standpoint of their importance to child life.

The texts show the greatest variation when compared from the standpoint of their organization. On this basis they may be divided into 5 groups.



Showing percent of pages devoted to various sciences.

In one group are those in which no organization is apparent. The text consists of a miscellaneous list of topics grouped into chapter headings in an unrelated way.

In a second group are those which are organized on the special science basis. They include brief text books in several special sciences bound under one cover.

The remaining groups have a real general science organization. In the third group the basis for organization is found in the subject matter.

In the fourth and fifth groups the basis is found in human life. In one group the material is organized from the adult's standpoint, in the other group it is organized from the child's standpoint.

The extent to which a real general science organization had been effected was easily seen while determining the number of pages devoted to the different sciences. In some cases the dividing line between the sciences was so sharply drawn that it was apparent at a glance. In other cases the material was so well organized from a general science standpoint that great care was necessary in order to separate the parts of the discussion according to the sciences involved.

From the standpoint of providing practical laboratory and field work, the texts may be divided into two groups, those which furnish text discussion and directions for practical work in the same book, and those which provide only text discussion. In many cases the authors in the second group have published separate laboratory manuals.

Most of the books in the first group tend to limit the practical work to that which can be done in the laboratory, but a few suggest outside work. Some of the books provide only one type of practical work; others provide several types of work but designate them all by the same name; while a third group provides several types of work and makes a distinction in the designations applied to them.

How to Make a Thermometer

W. G. WHITMAN.

Apparatus and Supplies. 1 foot length of thermometer tubing having a bore of about 1 mm. Small crucible of colored alcohol, Bunsen burner, clamp for holding the tube.

The Bulb. Seal one end of the tubing by holding it in the flame at an angle of 45 degrees and rotating it slowly. As soon as sealed, heat the end very hot. When the flame is strongly colored yellow, blow in the end of the tube. Look at the end to see if the bore has been increased by blowing. If not repeat until the bore at the hot end is enlarged to about double its original diameter. Then heat, rotating rapidly (use fingers of both hands), until the tube in the flame is so soft that it would bend but for the rotation which keeps it straight. Now

quickly remove from flame hold vertically and blow. A bulb should be formed. Continue heating, and blowing as just directed until a bulb half to three quarters of an inch of diameter is secured. Each time you heat, try to get more of the glass of the stem close to the bulb softened and worked into the bulb. This gives more glass to the bulb and ensures thick strong walls. If the bulb will not stand gentle tapping on the bench, it is too thin, and another bulb should be made. If this is necessary, make a scratch with a file just above the bulb, and break off the old bulb.

Filling the thermometer. A large sheet of asbestos should be used to cover the bench. Color 5 cc. denatured alcohol with blue or red dye. Dip the open end of the thermometer stem into the alcohol. With a Bunsen flame carefully warm the bulb, expanding and driving out the air. This air bubbles out through the alcohol. Remove the heat, and let the bulb cool. Explain why the alcohol rises in the tube as the bulb cools. The bulb may be cooled more rapidly by covering it with wet filter paper or a few drops of cold water. The bulb is perhaps about half full of alcohol. Hold the tube by means of a clamp. Heat bulb carefully in flame. The tube should be inclined about 45 degrees, and away from any inflammable substance so that any alcohol which spurts out will not be set on fire. When boiling begins, quickly invert, placing open end of tube in the alcohol. As it cools the alcohol will fill the bulb. If much air should remain in bulb boil again. If only a small bubble remains, draw out a fine capillary tube by melting a piece of glass tubing and drawing it out quickly when soft. Cut off a piece of this of right length. This must be small enough to go inside the bore of the thermometer tube. With this, work the liquid in the stem down and the air out, when the air bubbles are well up in the stem, they may often be removed by jarring. Hold the tube firmly with the fingers of one hand, strike this hand a downward blow against the other, centrifugal motion is also effective in replacing the last part of the air. Holding the tube by the open end make a full arm swing as quick and strong as possible. Repeat until the liquid is all shaken down to lower part of the tube. The alcohol should fill the tube two to three inches above the bulb.

Sealing. Place the thermometer bulb in water at 160° F. After five minutes, seal the tube above the alcohol.

Keep the flame well above the alcohol in the tube. A blow-pipe flame is best. Soften the glass an inch or so below the top and pull off the top portion. Continue to heat the top end, pulling off the hanging strings of glass until the tube has a well sealed and rounded top.

The Scale. Place the thermometer in a vessel of water at 165° F. The water should be deep enough to cover the alcohol in the stem. Place a mercury thermometer in the water. When the water has cooled to 160° F. make a fine file scratch on the glass tube at the top of the alcohol column. Mix cold and warm water until the temperature is just 60° F. Mark the level of the alcohol at this temperature with a file as before, mark a distance equal to space between these two scratches on paper. Divide the space into 20 equal parts each part represents 5°. These may be divided into smaller units. Make a scale to be fastened to the thermometer tube, continuing the scale by equivalent intervals to reperesent temperateure as low as 0° F.

Municipal Fire Signaling Sixty Years Ago and Now

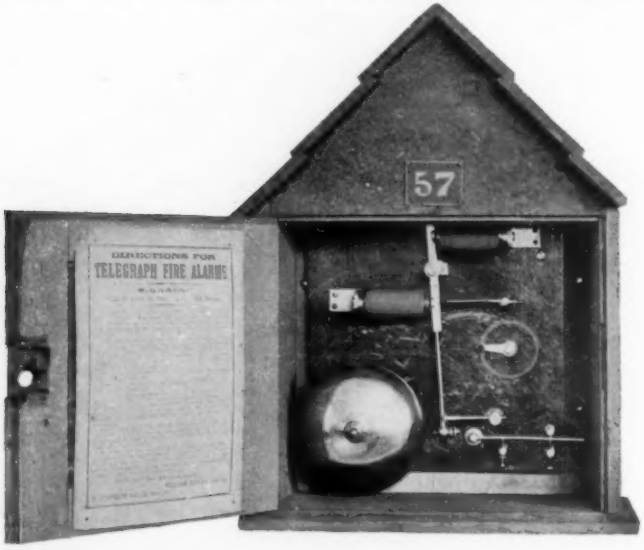
W. J. CARROLL, of the Gamewell Fire Alarm Telegraph Co.,
Newton Upper Falls, Massachusetts.

Something over sixty years ago the fire alarm telegraph was invented. Like many other inventions the first attempts seem crude viewed from today, yet also like so many other cases the basic principle of the first box is the principle that has survived until now.

The original box contained practically nothing but a telegraph key operated by a notched wheel that opened and closed the circuit. That principle, an electric current interrupted mechanically, still continues in use. The protection of this primary function has, however, developed the box until today the fire alarm box looks but little like its forefathers. The motive power is now supplied by clock-work instead of manually. The tripping lever is so arranged that once the mechanism is started it cannot be interrupted either through ignorance or malice.

Fire alarm boxes are arranged twenty or twenty-five on a circuit which forced the invention of the non-interfering de-

vice which prevents one box from cutting in on another while it is in operation and mutilating the signal. This invention was followed quickly by the invention of the successive feature which permits two or more boxes operated simultaneously to send in their signals over the circuit one after the other.



First Fire Alarm Box. It was used in Boston in 1855.

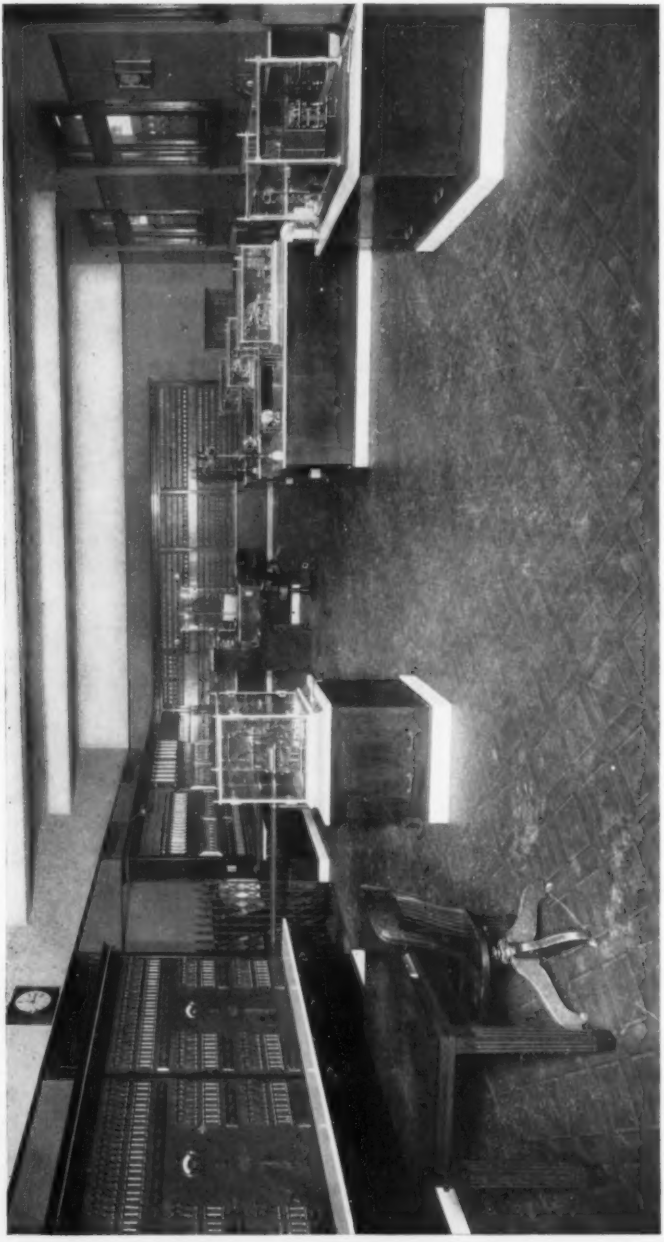
The changes in the construction of the box have kept pace with the development of its functions. Efficient lightning arresters protect the box against foreign currents where the original box had no protection. Wood for insulation gave place to hard rubber to be succeeded quickly by slate and finally by porcelain. After countless experiments commercially pure silver has been decided on as the most efficient dependable material for contact surfaces. The original cases of frail construction have been succeeded by double cast iron cases some of which have stood on the streets of cities for thirty-five years and battled successfully with water, wind, dust and time.

The changes in the central stations have been fully as great. The original Boston office was little more than a terminal point for the circuits carrying the street boxes and the circuits running to public alarms. Today with the tremendous increase in number of boxes the modern central office is as different from the original as the big modern telephone switchboard is different from the village switchboard. Individual, and in most cases isolated buildings, are provided to house the

switchboard, batteries, recording sets, transmitters and repeaters. A corps of operators are constantly on duty and the engineering problems which have arisen resulted in the creation of fire alarm engineering as a separate and specialized branch of engineering.

Working parts of a Fire Alarm Box of Today.

The growth of the fire alarm industry has been so steady because the need of a swift errorless method of transmitting signals has always been clear. Swift and errorless describes briefly the fire alarm telegraph and explains why the telephone and other devices have never been more than auxiliaries to the fire alarm telegraph system.



Fire Alarm, Central Office, Newark, New Jersey.

General Science as a College Entrance Subject

Reports from Colleges and Universities Regarding the Acceptance of General Science as a College Entrance Subject.

Otis W. Caldwell, Lincoln School of Teachers College, N. Y. C.

It is often asserted by school men that one of the obstacles to improvement of courses of instruction in secondary schools is found in the fact that colleges and universities are unwilling to accept new types of content for college entrance. It is well known, however, that certain colleges and universities have shown much liberality in accepting any courses which, in the judgment of secondary school people, give promise of preparing pupils so that their work may be more thoughtful and more effective. A committee of students of secondary education decided to secure definite information regarding whether colleges and universities formally accept for college entrance the subject commonly known as general science. Those who collected the information are Mr. H. A. Carpenter, Miss Irene Jameson, Miss Martha Shea, Miss Ellen Woodyard, and the writer of this paper.

A list of colleges and universities was prepared with the thought that an extensive sampling would fairly represent the situation throughout the whole country. Between January 29, 1920 and February 19, 1920 a copy of the following letter was sent to each one of the 133 colleges and universities:

"A group of science teachers and administrators who are interested in the various movements which have to do with improvement of science teaching, desire to find out which of our advanced educational institutions are now giving full credit for the course which is commonly known as general science. We refer to the general science course when used as a full year of introductory science study in the accredited high schools.

Does your institution accept general science for entrance credit, and is this credit classified as a science unit?"

At the time of completion of this summary (March 16, 1920) 116 replies have been received. One of these is from an institution which does graduate work only, to which the inquiry was inadvertently sent. There are thus 116 replies to be considered. A summary of the reports follows:

I. Institution to which letters were sent.

A. Kind of institution

1. State Colleges and Universities 57
2. Endowed, Private, or City Colleges and Universities 76

Total.....133

B. Geographic distribution of institution

1. East of the Central States and of a line South from the Eastern line of Ohio 54
2. Central States and Westward 79

Total.....133

II. Replies.

A. Eastern Group 49

1. Accept subject for college entrance 34
2. Do not accept subject for college entrance 15
3. Credit subject as science unit 18
4. " " " elective unit 8
5. Do not reply whether credited as science unit.. 8

B. Central and Western Group ..67

1. Accept subject for college entrance 65
2. Do not accept subject for college entrance 2
3. Credit subject as science unit 41
4. " " " elective unit 12
5. Do not reply whether credited as science unit 12

C. Total replies considered 116

D. Total which credit general science for entrance 99

There is given below the names of the colleges and universities to which the inquiry was addressed. Those from which no replies have been received are preceded by a "*". Those which report that they do not credit general science for college entrance are preceded by an "x".

Alabama
University of Alabama
Howard College
Arizona
University of Arizona
Arkansas
University of Arkansas
*Ouachita College
California
University of California
Leland Stanford Jr. University
Univ. of Southern California
College of the Pacific
Colorado
University of Colorado
Colorado School of Mines
University of Denver
Connecticut
xYale University
xWesleyan University
Connecticut Agr. College
Delaware
*Delaware College
District of Columbia
American University (strictly graduate)
xCatholic Univ. of America
Georgetown University
Howard University
George Washington Univ.
Florida
*University of Florida
Florida State Col. for Women
Georgia
*University of Georgia
Clark University
Agnes Scott College
Idaho
College of Idaho
University of Idaho
Illinois
University of Chicago
xUniversity of Illinois
Northwestern University
Indiana
Indiana University
Wabash College
xPurdue University
University of Notre Dame
Iowa
State University of Iowa
Drake University
Kansas
University of Kansas
Washburn College
Kansas State Agr. College
Kentucky
University of Kentucky
Berea College
Louisiana
*Louisiana State Univ. & Agr. & Mech. College
Tulane Univ. of Louisiana
Maine
Bowdoin College
University of Maine
xGoucher College
xJohns Hopkins University
Maryland
Maryland State Col. of Agr.
Massachusetts
xAmherst College
xSmith College
xHarvard University
Clark University
Boston University
Michigan
University of Michigan
*Albion College
*University of Detroit
Michigan College of Mines
Minnesota
University of Minnesota
*College of St. Teresa
Mississippi
University of Mississippi
Missouri
University of Missouri
*St. Louis University
Washington University
*William Jewell College
Montana
Montana State Sch. of Mines
University of Montana
Nebraska
University of Nebraska
Nebraska Wesleyan Univ.
Nevada
State University of Nevada
New Hampshire
xDartmouth College
New Hampshire College of Ag. & Mech. Arts
New Jersey
Rutgers College
xPrinceton University
New Mexico
University of New Mexico
New Mexico College of Ag. & Mech. Arts
New York
xColumbia University
Syracuse University
Hamilton College
Cornell University
Colgate University
xCollege of the City of N. Y.
xVassar College
New York University
North Carolina
University of North Carolina
North Dakota
University of North Dakota
Fargo College
Ohio
*Western Reserve University

University of Cincinnati
Oberlin College
Ohio University
Ohio Wesleyan University
Ohio State University
Oklahoma
University of Oklahoma
Oklahoma Col. for Women
University of Oregon
Reed College
Oregon
Pacific University
Pennsylvania
xBryn Mawr College
Swarthmore College
Lehigh University
Alleghany College
University of Pennsylvania
University of Pittsburgh
Rhode Island
Rhode Island State College
Brown University
South Carolina
University of South Carolina
*College of Charleston
South Dakota
*State School of Mines
University of South Dakota
Tennessee
University of Tennessee
George Peabody College for Teachers
Fisk University
*University of the South
Vanderbilt University
Texas
University of Texas
*Trinity University
Utah
Ag. College of Utah
University of Utah
Vermont
University of Vermont & State Agr. College
Middlebury College
Virginia
*William & Mary College
xRandolph Macon Woman's College
University of Virginia
Washington & Lee University
Washington
State College of Washington
University of Washington
West Virginia
West Virginia University
Davis & Elkins College
Wisconsin
University of Wisconsin
Lawrence College
Beloit College
Wyoming
University of Wyoming

Few of the replies include comments beyond specific replies to the inquiries in the letter. However, a few are of special interest and are quoted:

"In reply to your inquiry concerning credit given for general science courses in high school, I beg to say that we do not give credit for such courses. We require that a year's time be spent on some particular branch of science, such as chemistry or botany, etc. We regard the attempt to introduce general science courses into the schools as unfortunate. It brings science teaching strictly onto a text book basis. The text books presented are little more than reading books, illustrated and interesting, but not offering any thorough training in any science nor even in scientific study. It is adding one more item to the numerous ones already in our high school curricula, which are merely informational and not educational, a tendency which I regret very much and which reflects itself seriously in the ability of the high school student to study or work."

"In reply to your letter of January 29, I beg leave to state that the Board of Trustees of the University have not as yet approved credit in general science for admission to this University. However, the question is now being considered by the faculty and it is possible that recommendation will be made soon to the Board that general science be added to the list of subjects acceptable for admission to this institution."

"In reply to your inquiry, I beg to state that our committee on admission has not as yet given full credit to the course in general science as included in the first year of the curriculum of some of our high schools. The reason for the attitude of our committee is found in the conviction that this subject has not yet been thoroughly worked out as to content and method of presentation. I may add, however, that in case of individual schools the credit has been granted in the past and in all likelihood we shall extend this privilege to a larger number of schools in the future."

"Answering your inquiry of January 29th I beg to report that this College recognizes the year of work commonly known as "General Science" with the assignment of a full unit of entrance credit and we call the credit thus granted a science unit. We have the additional requirement, however, that each student who enters must present a year-course of work in *one* of the following science subjects: Physics, chemistry, biology, botany, zoology, physical geography."

"Replying to your favor of the thirtieth I can say that for a considerable time we took no account of "General Science" so called; but more recently principals of excellent schools have expressed to us the belief that the course as introduced in their schools was worthy of full credit as a unit in science. Therefore, upon such recommendation we have been accepting the course and crediting it as a unit in science."

"With regard to your letter of Jan. 30th, I have submitted the question of recognition of general science as an entrance subject to our committee and they are willing to accept it for elective unit if it is the course approved by the Regents and is taught in high school and not in the grades."

"I have your inquiry concerning the granting of credit for a course in general science. If such a course includes acceptable laboratory work, and is done in an accredited high school,

we allow one unit for admission to college."

"We give entrance credit for the course in general science when taken in a standard high school. We have in some cases allowed it to count as the required science for college entrance where evidence was presented that the course was well organized and that proper laboratory work was completed."

"I will say that this University accepts general science when it includes a substantial amount of competently supervised laboratory work in an accredited high school in fulfillment of the Science requirement for admission to the university.

In other words, general science is accepted as an entrance credit and is classified as a Science unit."

"Our own high school, which is the laboratory of the Department of Secondary Education gives a course in general science and particularly emphasizes it. It has been the opinion of our last two professors of secondary education that this is the very best form of high school science. Afterwards, we offer physics, zoology or chemistry and some years, give physical geography and botany but we always require a general science course to be taken."

Since 99 of 116 institutions reporting now credit general science for college entrance, and since some of the remaining 17 institutions express the possibility of an early acceptance of the subject, it is quite evident that colleges and universities are cooperating in the efforts of secondary school teachers to improve their work. It is well known that some of the institutions which have not formally approved general science for college entrance, have approved this course for individual students for several years. Furthermore, the comments in the replies are most timely in calling the attention of science teachers and administrators to the need of keeping general science truly scientific, and of making its content of real significance to pupils. Also it is urged that the general science course be well founded upon adequate experience in laboratory and environmental studies. There is a genuine danger that introductory science courses may sometimes become trivial, and sometimes so fragmentary or textbookish as to be unworthy the name of science. It is highly important that science teachers shall meet the confidence placed in them by still further improvement of the general science course.

Studies of The Masters

V. PASTEUR

By JOHN F. WOODHULL

"From the lives of men whose passage is marked by durable light let us piously gather up every word, every incident likely to make known the incentives of their great souls, for the education of posterity."

Thus wrote Louis Pasteur whose constant study was the lives of the Masters. This disciple of Biot and Dumas became himself a great master whom France in 1910 voted the greatest Frenchman. He was born December 27, 1822, at Dole, a small village in eastern France, about seventy-five miles from Geneva and two hundred miles from Paris. It is a pleasure to record that this man from early youth admired his teachers and was admired by them. There was one exception, however, a certain science teacher, named Darley, who found this boy of seventeen too full of questions. He sighted for "the gold old times when pupils were less inquisitive."

Pasteur was considered slow and was rated as only a "good average pupil." He was serious minded and preferred the intimacy of grown persons to those of his own age. While yet a boy of high-chool age, he was a portrait painter of considerable merit. At eighteen he took the degree of *bachelor of letters*, having studied for this degree Latin, Greek, French, history, geography, philosophy, and science. He was a general reader and a lover of books, differing in this from many science students, who are indifferent to literature, and to some literature students who affect to disdain science. The study of mathematics seemed to him "dry and exhausting." He wrote "one ends by having nothing but figures, formulas and geometrical forms before one's eyes." He found relief from mathematics in reading "charming stories" over which he did not disdain to weep.

At twenty years of age he took the degree of *bachelor of science* with a record of *mediocre* in chemistry, and in the same year went to Paris to cram for high standing in the entrance examinations to the Ecole Normale. He was admitted fourth on the list in 1843 at 21 years of age. While engaged in this cramming process his real education progressed by two means:

1. He spent much time in the library reading in philosophy and lecture, and, 2. Like so many other great scientists, he began his future career by attending inspiring public lectures in science. These were given by J. B. Dumas, the successor of Gay-Lussac, at the Sorbonne. According to Pasteur's testimony, the lecture room was immense and always quite full. He had to be there half an hour before the time to get a good seat "as you would in a theatre; there is a great deal of applause; there are always six or seven hundred people." He called himself a "disciple", full of the enthusiasm inspired by Dumas. At this same time Faraday was making many disciples, by the method of the public lecture as Davy and a host of others before and after him have done in England, and as Gay-Lussac and a host of others did in France.

In 1844 when Pasteur was twenty-two, the age of the modern college senior, he attacked a project in chemistry which had seemed an insurmountable difficulty to such great scientists as Mitscherlich in Berlin and Biot in Paris.

Two substances, which by chemical analysis were proven to be composed of the same elements and in the same proportions, and hence, to which the same formula must be applied, were nevertheless very different in characteristics. Such a pair of substances were, for example, sodium tartrate and sodium paratartrate. The first rotates the plane of polarized light while the second does not. The solution of this enigma was the project ever in Pasteur's mind during the next three years. It however must needs be an extra-curricular study while he was pursuing the formal courses leading toward the examination for the degree of doctor of science. On September 17, 1846, while yet not quite twenty-four years of age, he passed his examination for the degree of doctor of science, third in a list of fourteen candidates. The jury consisting of Dumas, Balard and Delafosse said "he would make an excellent professor" which turned out to be true, although how they knew, it is impossible to guess.

In May, 1848, he solved his first great project. He found that tartaric acid crystallized in two forms, one being left-handed and the other right-handed crystals. One kind produced the image of the other when held before a mirror. Solutions of the right-handed crystals were capable of rotating the plane of polarized light to the right, while solutions of left-handed

crystals rotated it to the left. A mixture of equal quantities of each was neutral to polarized light. *This was paratartaric acid.* Thus the doctrine of isomerism was promulgated by Pasteur and his fame immediately went forth to all the world. His son-in-law writes "His excitement was such that he could not look at the apparatus again; he rushed out of the laboratory, not unlike Archimedes. He met a curator in the passage, embraced him and dragged him out into the garden to explain his discovery. He foresaw all the consequences of his discovery." One of which was that Biot, Dumas, Balard and Reqnault were very ready to present him to the Academy of Sciences. For the solution of this project he received the red ribbon of the Legion of Honor, a prize of 1500 francs from the Pharmaceutical Society and the Rumford Medal from the Royal Society of Great Britain.

To be a graduate of the Scole Normale means that one must be ready to serve France as a teacher for at least ten years and he was now sent by the Minister of Public Instruction to be teacher of physics at the Dijon Lycee (comparable to one of our high schools). He had as many as eighty pupils in a class at one time. He wrote "It is with great difficulty that I can secure the attention of all towards the end of the lesson. I have only found one means, which is to multiply experiments."

In 1849 he was promoted to an assistantship in chemistry in the University of Strasburg in Alsace. Here he married the rector's daughter, Marie Laurent, May 29, 1849, his age being twenty-six years.

In September, 1854, (at 32 years of age) he was made professor and dean of the Faculty of Science at Lille, the richest center of industry in the north of France. He directed that the university should serve the community in its special needs. One of its functions in this rich agricultural region was to test manures. Inspired by the lives of illustrious men, great scientists and great patriots, Pasteur himself became a great teacher of youth. He acquired the gift of making science interesting to all minds, even those who were naturally least inclined to that line of thought. He rendered his listeners' attention very easy. No question surprised him and he never smiled at ignorance. His students acquired not merely a taste, but a genuine passion for study. His lectures were attended by 300 students.

He took his pupils on excursions to factories, iron founderies, steel and metal works in the region of Lille and over into Belgium.

In 1856 a manufacturer of beet-root alcohol at Lille sought Pasteur's advice regarding some troubles in the process of fermentation. This became Pasteur's second great project. Berzelius and Liebig had taught that fermentation was due to catalytic action and this was universally accepted. Pasteur noticed through the microscope that globules were present when fermentation was healthy and that they lengthened when failures in fermentation occurred. In 1957 he concluded that all kinds of fermentation and perhaps of contagion, were due to the action of minute living organism. This was the beginning of the germ theory of fermentation and disease which was destined to work a mighty revolution. It was his work that banished from the world the fantastic idea of "spontaneous generation."

In that year Biot, Dumas, Balard and Senarmont insisted upon presenting his name to the Academy of Sciences as a member. Because of his work in crystallography while solving the paratartaric acid project, they thought it wise to present him to the section in Mineralogy. But the members of that section did not know him as a Mineralogist and he was rejected, receiving only 16 votes when he needed 30. He could not be recognized as a scientist if he did not specialize and he could not solve his projects if he did specialize. Pasteur said that his researches were founded upon many sciences and hence the specialists could not follow them.

In 1857 he was summoned to undertake the management of the Ecole Normale and in 1860 the Academy of Sciences conferred on him the prize for Experimental Physiology. In 1861 there was a vacancy in the Botanical Section of the Academy of Sciences. Biot desired to nominate him as a candidate saying "I can hear the commonplace objection, he is a chemist, a physicist, not a professional botanist.—But that very versatility should be in his favor." Pasteur had submitted to the Academy during the previous twelve years twenty-one papers on remarkable researches. Balard joined Biot in this campaign, but Pasteur was rejected, receiving only twenty-four votes. On December 8th, 1862, when Pasteur was forty years of age, he was elected a member of the Academy of Sciences, receiving

only thirty-six out of sixty votes. "The next morning, when the gates of the Montparnasse cemetery were opened, a woman walked towards Biot's grave with her hands full of flowers. It was Mme. Pasteur who was bringing them to him who had loved Pasteur with so deep an affection", who had tried repeatedly to have Pasteur elected to the Academy of Sciences, but had died a few months before without accomplishing this end.

In 1864 France was in danger of losing one of its great industries. Wines were becoming diseased; acid, bitter, "ropy". Pasteur's third great project was to find a cure for this trouble. He introduced the custom which has been practiced ever since of heating the wines to 130°, and killing the offending bacteria, and this process has saved the wines ever since. For the solution of this project he received a prize medal from the government in the presence of a grand concourse of royalty from many nations, 17,000 persons being present.

In 1865 an epidemic was ruining the silk-worm industry of France which yielded more than $20,000,000 annually. Pasteur was chosen by the government to study this project. He went at it reluctantly because he had had no experience whatever with silk worms. Still his scientific ardor and generous eagernesss to lighten the burdens of humanity impelled him to it. While in the midst of these studies, he had a stroke of paralysis incapacitating his left side, but in time recovered and completed the solution of this his *fourth project*. He found that it was another case of noxious bacteria and discovered a method which restored the silk industry to the world.

Pasteur's son-in-laws says: "Jealousies began their work of undermining; pseudo-scientists proclaimed everything illusory and silk worm merchants, willing to ruin everybody rather than jeopardize their miserable interests did not hesitate to perpetrate the most odious falsehoods."

Pasteur wrote "Let us endeavor to distract our thoughts from human turpitude by the disinterested search after truth. —A man of science should think of what will be said of him in the following century, not of the insults or the compliments of today.—Every progress is opposed by prejudice, petty jealousies and indolence." Dumas wrote to him "You have quacks to fight and envy to conquer. It is not likely that they

will be converted or reduced to silence. The best way is to march right through them, Truth leading the way."

Few men have realized as did Pasteur that laboratories may be the vestibules of farms, factories and so forth. Science he thought was intended to lighten the burdens of humanity, make labor more fruitful, and intelligence more universal.

Austria presented him with a great prize for this work on silk-worm diseases, Italy offered him a professorship at the University of Pisa, where Galileo had taught nearly three hundred years before, and France gave him a life annuity of $2400.

His fifth great project occupied about ten years. It was not until February 28, 1881, that he communicated to the Academy of Science his discovery of "vaccination by attenuated virus." This marvelous piece of work he had accomplished while studying fowl cholera and splenic fever. Pasteur's method of work was this:

1. The germ suspected of being the cause of a disease was isolated from other germs.
2. A suitable culture medium was found upon which the germ would thrive outside the animal body, which was its natural host.
3. The animal was innoculated with this germ to determine whether it could produce the disease.
4. The germ was grown in a culture medium in a weakened condition, by being exposed to the oxygen of the air or by varying temperatures or by varying the character of the culture medium. This culture medium containing weakened germs he called "attenuated virus."
5. The animal was vaccinated against the disease, i. e., innoculated with the attenuated virus. It would have a mild case of the disease and after recovery would be immune from the more virulent disease.
6. The vaccinated animal was innoculated with virulent virus to prove its immunity. Meanwhile the Academy of Medicine was discussing whether to treat diseases by cold baths or drugs or not to treat at all, and one of its members said what do we want with chemists, physicians or physiologists. Physiology can be of no practical use in medicine; it is but a *science de luxe* which could well be dispensed with. Quite different this from Huxley's idea that physiology is the chemistry and physics of the human body.

At every incursion of Pasteur's on the domain of medicine he was looked upon by the French medicine men as a mere chemist, poaching on the preserves of others. He had already received the honorary M. D. degree from the University of Bonn. He had also received from the great British surgeon, Sir Joseph Lister, a letter of appreciation and thanks, saying that Pasteur had been the first to demonstrate the truth of the germ theory upon which alone the antiseptic system which he himself used was based, and inviting Pasteur to visit his hospital at Edinburgh and see how largely mankind is being benefited by his labors and how greatly surgery is indebted to him. Lister at that time was saving thirty-four out of forty in surgical operations by using Pasteur's methods while these French surgeons were losing practically all of their patients. Under these circumstances Pasteur was elected to the French Academy of Medicine by the narrow majority of one vote.

People "who borrowed assurance from a mixture of ignorance and prejudice" were easily led to have faith in his conclusions at one time and to discard them at another, but scientific persons saw the facts proven and never receded from their belief. There were, however, vicious and most persistent attacks upon Pasteur and to satisfy carping critics he agreed to perform a great demonstration experiment at the town of Melun. On May 5, 1881, he vaccinated with the attenuated virus of splenic fever, 24 sheep, 1 goat, 5 cows, and 1 ox. This vaccination for immunity he repeated twelve days later, on May 17. Fourteen days later, on May 31, he announced that these were immune from attacks of splenic fever and to prove it they together with another (unvaccinated) group composed of 24 sheep, 1 goat, and 4 cows were innoculated with a most virulent virus of splenic fever. All of the second group died in five days and all of the first group remained well.

Pasteur received a medal of honor from the Society of French Agriculturists and the Grand Cordon of the Legion of Honor from the French Government. The next year at the age of sixty he was elected a member of the French Academy (not to be confounded with the Academy of Sciences). Various towns and scientific societies struck medals with Pasteur's effigy on them. Huxley said Pasteur's discoveries alone would suffice to cover all the war indemnity paid by France to Germany in 1870.

The French Government increased his pension to $5,000 a year to revert first to his wife and then to his children. He received the LLD degree from the University of Edinburgh. Many streets were named Pasteur throughout the world, and one province in Canada on the boundaries of Maine bears his name as does also a village in Algeria.

Thus far his innoculations were performed wholly upon animals, but on Monday, July 6, 1885, a woman from Alsace came into Pasteur's laboratory bringing her nine-year-old son, Joseph Meister, who had been bitten two days before by a mad dog. With great anguish Pasteur began the treatment of this lad, innoculating him twelve times in ten days with attenuated virus of increasing strength. Meister's life was spared and immediately hydrophobia patients from all over the world began to flock to Pasteur's laboratory, including four American children sent by a New York Herald subscription. In six months from the cure of Meister, three hundred and fifty persons had been saved from hydrophobia by Pasteur. He lost none whom he treated except one who had come to him thirty-seven days after being bitten. Rich and poor from all lands, including the Czar of Russia, the Emperor of Brazil, the Sultan of Turkey, and the populace of Alsace-Lorraine, sent subscriptions for Pasteur's first Institute for the treatment of hydrophobia, and among all these names Pasteur found that of Joseph Meister who had been his constant correspondent since his cure. During this time thousands of cattle and millions of sheep were vaccinated for splenic fever.

On September 28, 1895, in the seventy-third year of his age, Pasteur died and his tomb is now in a chapel connected with his first institute. That he was deeply religious and passionately devoted to the service of humanity will appear from the following quoted from himself and from his son-in-law.

A favorite book of his was one regarding the *Knowledge of God and of Self*. He believed in a religion free from all controversy and all intolerance; a religion of peace, love and devotion. A man's life is worthless if not useful to others. Men of science aspire to originating vast benefits to the whole of humanity. The cultivation of science is perhaps even more necessary to the moral condition than to the material prosperity of a nation. Great discoveries raise the intellectual level and the moral sense and through them the Divine idea itself is

spread abroad and intensified. It would indeed be a grand thing to give the heart its share in the progress of science,—science which brings man nearer to God.

When one of his daughters died he said "She is happy. Let us think of those who remain and try as much as lies in our power to keep from them the bitterness of this life." "My philosophy is of the heart and not of the mind and I give myself up to those feelings about eternity which come naturally at the bedside of a cheerful child drawing its last breath."

Science was intended to lighten the burdens of humanity. Nothing is more agreeable to a man who has made science his career than to increase the number of discoveries, but his cup of joy is full when the results of his observations are put to immediate practical use.

It is always a mistake not to doubt when facts do not compel you to affirm. The greatest aberation of the mind consists in believing a thing because it is desirable. The scientific person puts his faith in the natural, the unscientific person puts his faith in the unnatural. Many things are to him mystical and he likes to call them supernatural. It seems impossible to these whose ideas come from an ardent faith to understand that a man may seek truth for its own sake and with no other object than to proclaim it.

His mind rose far beyond this earth in his reverence for the memories of the heroic and benevolent souls of great men, a sacred and intimate bond between the visible and the invisible worlds. He carried in the depths of his soul a constant aspiration toward the Ideal, a deep conviction of the reality of the Infinite, and a truthful acquiescence in the Mystery of the Universe. He believed in an Infinite Wisdom, and Absolute Power, an Infallible Rectitude. He had that intuition which makes a great poet of a great scientist. His imagination often carried him to a summit whence an immense horizon lay before him. He associated in his person the faith of an apostle with the inquiring patience of a scientist. "I have a lasting provision of faith and fire and I much prefer criticism to praise."

Pasteur dreamed of an educational regime where there would be no constraint, no hard and fast rules, no curriculum, but that of free study. He liked to think how Dumas and Balard,

greatest of chemists and members of the French Academy, both began as apothecaries.

Pasteur opposed the idea that each science should restrict itself within its own limitations. One science does not hamper but help another. All sciences gain by mutual support.

Pasteur never accepted invitation to those large social gatherings which are a tax laid by those who have nothing to do on the time of those who are busy. He never went to the theatre. He retired at ten and arose at eight.

His labors may be summarized under three heads:

1. Each fermentation is produced by a special microbe. As a result of this discovery the wine, vinegar, and beer industries were saved.
2. Each infectious disease is produced by a special microbe. As a result of this discovery cattle are saved from the contamination of splenic fever, silk worms from pebrine and flaccery, and surgical operations have become less deadly.
3. The microbes of infectious diseases may be attenuated so that a virus becomes a vaccine. As a result of this cattle exposed to anthrax, (splenic fever) swine exposed to rouget (swine fever), poultry exposed to cholera, and men and animals exposed to hydrophobia may be saved from these diseases.

A memorial plate is on the door of the house in Dole where he was born, and mass is celebrated on each anniversary of his death in the chapel where he lies.

Book Reviews

Science of Home and Community.—Gilbert H. Trafton. The Macmillan Co. 561 pp. 217 illus.

No General Science book has appeared previous to this one which so well organizes the science around the pupil's environment, and at the same time selects material important in itself and appealing to the pupil. The subjects of "Hygiene," "Home Pleasures," and "Useful Devices of the Home," find a place here, as does also the "Use of the Home Grounds." A study of the various means of travel and communication leads one away from the home. There are five important chapters on the "Health of the Community," and one chapter on "Alcoholic Drinks." "Conservation of Community Resources," "Weather," and the "Heavenly Bodies" are other topics treated. The book is admirably written, and will appeal to Junior High School pupils. Many demonstrations are outlined and numerous home projects are suggested. There are questions and references. The book, with the average teacher, will stimulate pupils to a better citizenship.

Studies in Science—Alice J. Patterson. Row, Peterson and Co. 480 pp. 86 illus.

The book is designed for use in the seventh and eighth grades of the Junior High School. It leans strongly toward the usual nature study, and is strong in its bearing on agricultural subject matter. About one-sixth of the book is devoted to physical science which seems rather small for the average pupil. No attempt is made to use or to suggest the problem-project method, though "Home Projects" really home experiments, are suggested in connection with garden studies. It is not sufficiently well illustrated. The book will fill the need of some of the rural communities.

Junior Science, Book I.—John C. Hessler. Benjamin Sanborn Co. 243 pp. 123 illus.

Book I is essentially all physical science. It is divided into four parts, namely: "Introduction," "The Atmosphere and Its Relation to Man," "Matter and Energy in Earth and Sky," and "Science of the Household." This is to be followed by Book II in three parts: "How We Use Nature's Forces;" "Living Things and Their Relation to Us;" and "Our Bodies and How to Care for Them." Book II is not yet ready. The two books are intended for the Junior High School, or grades seven to nine. Book 1 is written in the same, simple and clear language and style as the author's "The First Year of Science." Many teachers would prefer that some attempt be made to use the modern problem-project method which is not even suggested here.

A Field and Laboratory Guide in Physical Nature Study.—Elliot R. Downing, University of Chicago Press. Loose-leaf. 109 pages.

This is not "Nature Study" as this term is commonly understood. It comprises a number of studies from the field of General Science. It is a laboratory book that will appeal to boys. The book tells about things that boys are naturally keenly interested in, rather than about topics which the average grown-up thinks he ought to be interested in. It will lead many boys into real construction projects. Here you will find all about toys that work by air, tops and slings, the hot-air balloon, magnetic and electric toys, the camera and magic lantern, the home made orchestra, how to make a telephone, and various other mechanical devices. The book is a companion volume to "The Field and Laboratory Guide in Biological Nature Study."

Fundamentals of High School Mathematics. Harold O. Rugg and John R. Clark, World Book Co. 373 pages. Illustrated. $1.60.

The book is prefaced by thirteen pages on the *scientific method in the construction of school text books.* This will interest science teachers as well as mathematics teachers. The book is for ninth grade or first year high school pupils. The excessive manipulation of symbolisms of formal algebra have in this book been replaced by material which is of far greater value. Graphs methods of direct and indirect measurement, the properties of the right triangle, and a comprehensive treatment of the relationship between changing quantities have replaced the elaborate treatment of factoring, factions, and operations with long polynomials. The book marks an advancement in first year mathematics.

Problems in Botany—W. L. Eikenberry, Ginn & Company. 157 pages. 72 cents.

This book contains 118 laboratory or field exercises, which, in the

main, have a practical bearing on the economic side of botany. The material is organized with reference to the *life* of plant rather than to the *structure*. Each exercise presents a definite problem for the pupil to solve. While the book was designed to accompany Bergen and Caldwell's "Introduction to Botany" and "Practical Botany," it can readily be used with any text.

Zoology—A Textbook for Colleges and Universities.—T. D. A. Cockerell, xii-568 pages. Illustrated with maps, charts, drawings, and photographs. Price $3.00.

This zoology is for the average individual who will not specialize in the subject

The first chapter is entitled "The Physical Universe," and it considers the fundamental ideas of physical science, taking nothing for granted. The treatment of the animal kingdom is at once broad and systematic. The great phyla and some of the sub-groups are discussed from the structural angle. More space than usual is given to a description of animals. The geographic origin and migrations of the world's fauna are ably considered. The topics throughout are developed in a way that makes delightful as well as highly instructive reading. It is a workable text of college grade.

The Community Center.—L. J. Hanifan. Silver, Burdett & Company. 224 pages.

This timely book was written from the standpoint of one possessed of an intimate knowledge of rural life. It is brief and concise and was written for the purpose of furnishing the teacher, superintendent, supervisor, or rural community leader with the definite, concrete aid necessary for successful leadership. It is designed for use in normal schools, normal training high schools, summer training schools, and all sorts of organizations for community improvement.

Briefly stated, the book presents some of the more important problems of rural social life and recreation, and offers suggestions as to how the teacher, by means of the school as a community center, may contribute very largely to the solution of these problems. Chapters I to V deal with some of the more fundamental principles underlying the community center movement, Chapters VI to X indicate the nature and scope of community activities, and Chapters XI and XII contain suggestive programs, most of which have been successfully used by teachers. A bibliography and index are included, and each chapter is followed by a set of exercises.

Food For The Sick and the Well.—Margaret P. Thompson, World Book Company, ix-82 pages. Price $1.00.

This is a book of practical receipts, which may be used in planning a well regulated diet for the sick and for convalescents, as well as for those who are well and wish to remain so.

The housewife as well as the physician and the nurse will find in this volume a valuable help and guide. The text discusses the relation of food to health and the necessity of a balanced menu.

An additional section of the book devotes itself to treatments such as baths, sponges, hot-packs, salt-rubs, poultices, mustard plasters, enemas, douches, and directions for the proper way of filling a hot-water bag.

General Science References

EARL R. GLENN

THE LINCOLN SCHOOL OF TEACHERS COLLEGE

COLUMBIA UNIVERSITY

The ambitious library program advocated by a recent report[1] suggests that the time has arrived for a more thorough study of the supplementary reference materials adapted to the beginner in science.

During the past seven years we have been searching for good elementary science readers for beginning pupils. Several hundred books have been examined in the best libraries of Chicago and New York. Not many satisfactory references have been found. A book for this purpose should meet the following requirements:

(a) It should be written by an authority.

(b) The language should be simple.

(c) The illustrations should be modern, well drawn, numerous, and properly printed.

(d) The printed page should be attractive.

(e) The book should have a good index and be of a recent edition.

(f) The style must interest the young reader. Very few of the references in this list will satisfy all of these requirements. However, it seems best to publish such a compilation as this from time to time in order that a satisfactory reference list may be evolved for general science. By elimination and constant revision a few really first class references[2] may be obtained for the more important topics commonly treated in a first science course.

Most of the reference books needed for general science must necessarily be non-technical. Many different fields of science must be represented. Some selections are needed to supplement the text in use. Others concern magazine articles. There should be a liberal supply of bulletins, charts, trade catalogues, etc., which can often be obtained free of charge. Some ref-

[This reference list is a revision of the list published in the Nov. 1918, QUARTERLY. It is now reprinted because of the large demand for copies of the article. Ed.]

1 Certain, C. C., Standard library organization and equipment for secondary schools of different sizes. Proc. N. E. A., 1916, Vol. LIV, pp. 547-558.

2 Glenn, Earl R., The relation of the school library to the teaching of science. Proc. of N. E. A. Vol. LVII, 1919, pp. 460-462. A brief summary of the library situation with respect to science.

erences will deal with history and invention; others will treat the occupational information closely related to the subject of study. This field has been too long neglected by the teachers of science. The teacher will require some technical references.

This list has been prepared to accompany the revised edition of "Elements of General Science" by Caldwell and Eikenberry, because this is the text the author has used in his class.

References have been compiled for 33 topics according to the general outline given below:

(A) General references supplmenting the text.

(B) Magazine articles. The references from Popular Mechanics, Popular Science Monthly, Scientific American, Electrical Experimenter, and other common periodicals are listed first. Articles from the more uncommon journals are given at the end of the list.

(C) Bulletins, charts, trade catalogues, exhibits, lantern slides, etc. (Chiefly free of charge.)

(D) History and invention.

(E) References giving information about the occupations related to the topic.

(F) Sources of technical information for the teacher.

PART I. THE AIR.

1. Interesting Things About the Air.

(A) General

1. Bureau of Standards. Measurements for the Household. Chapters 3 and 1 give excellent explanations for the aneroid barometer and thermometers.

2. Bodmer, Rudolph, Book of Wonders. (Deep sea diver, use of compressed air in New York City terminal construction, submarines.)

3. Turner, Charles, Aircraft Today. J. B. Lippincott Co. (Excellent in every respect.)

4. Corbin, T. W., Romance of Submarine Engineering, Seeley Service Co., London. (Chapter 1-5 Divers, and diving bells.)

5. Moffett, Cleveland, Careers of Danger and Daring. Century Co., 1917 (Balloonist and deep sea diver.)

6. Abbott, W. J., Aircraft and submarines, G. P. Putnam's Sons.

7. Keene, E. S., mechanics of the household, McGraw-Hill Publishing Co.

(B) Magazines

1. Ford, John A., New Tests Reveal Fatal Defects in Fliers. Pop. Mec., May, 1918. (Use of vacuum chamber to test aviators.)
2. Hucks, B. C., The Effects of High Flying. Sci. Amer. Sup. April 13, 1918.
3. Claudy, C. H., An airman's story. Sci. Amer., April 26, 1919.

(C) Bulletins, etc.

1. Jameson, P. R., The Barometer as the Foot Rule of the Air. Taylor Instrument Co. Rochester, N. Y. (10c.)
2. The Thermometer and Its Family Tree. Taylor Inst. Co. (10c.)
3. American Thermos Bottle Co. Catalogue, New York, N. Y.

(D) History

1. Fournier, E. E., Wonders of Physical Science. Macmillan Co. (Story of air pump and barometer.)
2. Cajori, Florian, History of Physics. Macmillan Co. (Air pumps, Guericke's water barometer.)

(E) Occupations

1. Weaver and Byler, Vocations for Boys (And girls). A. S. Barnes Co. (Lists 106 occupations and the schools in New York City in which special training is given. Many occupations closely related to science are given.)

(F) For the Teacher

1. Packard, John C., Everyday Physics. (Exercises 10 and 11 deal with air pressure and the barometer.) Ginn & Co.
2. Millikan and Gale, Practical Physics, Ginn & Co.

2. Air and Water.

(A) General

1. Bureau of Standards. Measurements for the Household. (Chapter 8. Atmospheric humidity. Excellent cuts and two very useful charts of wet, dry-bulb thermometer.

(B) Magazines.

1. Mauer, W. J., Ventilation of Army Barracks. (Interior and exterior views.) Heating and Ventilating Magazine ($1.00), November, 1917.

(C) Bulletins, etc.

1. Jameson, P. R., Humidity, Its Effect on Our Health and Comfort. Taylor Instrument Company, Rochester, N. Y. (10c.)

(D) History

1. Burns, Elmer E., The Story of Great Inventions. Harper Brothers. (The age of Galileo, the thermometer.)
2. New International Encyclopaedia, Dodd, Mead & Co. (Life of Fahrenheit.)

(E) Occupations

1. Weaver and Byler, Profitable Vocations for Boys. (Pages 5, 6, 9. Average occupations of 1000 typical men.)
2. Hopkins and Bond, Scientific American Reference Book, Munn and Company. (Distribution of occupations.)

(F) For the Teacher

1. Barber, F. D., First Course in General Science. Henry Holt & Company. (Chapter 4. Pages 212-250. The water of the air.

3. Air Temperature and the Seasons.

(A) General

1. Longstreth, T. M., Reading the Weather. Outing Pub. Co., New York. (70c.) (Weather bureau and weather flags.)
2. Farmer, A. N., and Huntington, J. R., Food Problems. Ginn & Co. (Typical graphs.)
3. World Almanac, 1919, (54c) (Calendar).

(B) Magazines

1. McAdie, A., Meteorology and the National Welfare. Scientific Monthly, February, 1918.
2. Anon. A Timely Adjustment. Sci. Amer. Dec. 28, 1918. (Standard time zones.)

(C) Bulletins, etc.

1. Time taking, time keeping, Elgin National Watch Co., Elgin, Ill. (Well illustrated.)

(D) History

1. Bolton, S. K., Famous Men of Science. (75c.) T. Y. Crowell & Co., New York. (Galileo, Newton.)

(E) Occupations

1. Moore, W .L., Descriptive Meteorology. ($3.00) D. Appleton & Co. (For young men who enter weather forecasting.)

(F) For the Teacher

1. Salisbury, R. D., Physiography. Henry Holt & Co. ($3.15) (Chapter 14, Temperature of the air. Chapter 11, Earth relations.)

4. The Weather.

(A) General

1. Hopkins and Bond, Scientific American Reference Book. Munn & Co. (Instruments used in U. S. Weather Bureau, Pages 485-498.)

(B) Magazines

1. The Weather for December, 1919. (Large graph.) Heating and Ventilating Magazine, 1920. (This chart is published each month from U. S. Weather Bureau records.)
2. Day, P. C., The cold winter of 1917-1918. Monthly weather Review. 47:570-580. Jan. 1919.
3. Flora, S. D., Kansas Tornadoes. Mon. Wea. Rev. July, 1919.
4. Davis, E. G., Snow and Astronomy. Monthly Evening Sky map, May 1919. (Snow crystals).

(C) Bulletins, etc.

1. Jameson, P. R., Weather and Weather Instruments. Taylor Instrument Company, Rochester, N. Y. (50c.)
2. Jameson, P. R., Practical Hints for Amateur Weather Forecasters. Taylor Ins. Co. (10c.)
3. Jameson, P. R., The Mountains of Cloudland and Rainfall. (Types of clouds and rain gauges. (10c.)
4. U. S. Hydrographic Office, Washington. Illustrated cloud forms, colored with text. Supt. of Documents, Gov. Printing Office, Washington.

(D) History

1. New International Encyclopaedia. Dodd, Mead & Company, (Life of Cleveland Abbe.)

(E) Occupations

1. Ward, R. DeC., Practical Exercises in Elementary Meteorology. Ginn & Company.
2. U. S. Weather Bureau, Washington. Instructions of Voluntary Observers.

(F) For the Teacher

1. Barber, F. D., First Course in General Science. Henry Holt & Company. Pages 274-311. (The deflection of winds, cause of seasons, factors which determine climate.)
2. Waldo, Frank, Elementary Meteorology. American Book Co.

5. Structure of the Air: Molecular Theory.

(A) General

1. Comstock and Troland, Nature of Matter and Electricity. D. Van Nostrand Co. (Chapter 3, Atoms and their behavior.)
2. Edelman, Philip E., Experiments. (Sold by author, Minneapolis, Minnesota.) (Chemical and electrical experiments.)

(B) Magazines

1. Sturdevant, C. R., Experiences of an Iron Atom. Sci. Amer. Sup., Jan. 5, 1918, Jan. 12, 1918.

(D) History

1. Thorpe, T. F., Humphry Davy. Macmillan Co.
2. Youmans, William J., Pioneers of Science in America. D. Appleton & Company.
3. Bolton, S. K., Famous Men of Science. (75c.) T. Y. Crowell & Company, New York.

(E) Occupations

1. Collins, A. Frederick, Inventing for Boys. (How to patent, manufacture, and market an invention.)

(F) For the Teacher

1. Soddy, F. Matter and energy.
2. Alexander, Jerome, Colloid Chemistry, D. Van Nostrand Co.

6. Composition of the Air: Atomic Theory.

(A) General

1. Baker, Abby G. and Ware, A. H., Municipal Government of the City of New York. Ginn & Co., (Chapter 14, The fire department. Duties of firemen.)
2. World Almanac, 1918. (54c.) (Fire department, New York City, p. 879: Imports of minerals, p. 665; Poisons in making explosives, p. 405.)
3. Official Handbook, Boy Scouts of America. Doubleday, Page & Co. (Questions on firemanship.)
4. New York Post, April 20, 1918. (Fire prevention, legislation, sprinklers.)
5. Toothaker, Charles R., Commercial Raw Materials. Ginn & Co., (Mineral products, iron, lead, zinc, copper, platinum, silver, mercury, aluminum, clay, tin, nickel, salt, lime, sulphur, glass, building stones.)

(B) Magazines

1. Darling, L. E., Our Annual Coal Drama. Pop. Sci. Mo. 92:530-536, April, 1918.

C. Bulletins, etc.

1. Johns-Manville Co., New York, Asbestos exhibit.
2. Joseph Dixon Crucible Co., Jersey City, N. J. Graphite exhibit.
3. Eberhard, Faber Co., New York. Graphite exhibit.
4. Royal Baking Powder Co., New York. Baking powder exhibit.

(D) History

1. Shenstone, W. A., Justus von Liebig. Macmillan Company.
2. Bodmer, R., Book of Wonders. (How man discovered fire.)
3. Faraday, M., Chemical History of a Candle. (75c.) Harpers, New York.
4. Venable, History of Chemistry. D. C. Heath.
5. Brownlee, Chemistry of Common Things. Allyn and Bacon.

(E) Occupations

1. Weaver and Byler, Profitable Vocations for Boys. A. S. Barnes Co. (Work of firemen.)
2. Same. (p. 139: Annual earnings in metal trades.)
3. Same. (pp. 225-229: Chemical occupations.)
4. Gowin, E. B. and Wheately, W. A., Occupations. Ginn & Co. (Chapter 11, The mining engineer; the metallurgical engineer; the industrial chemist.)

(F) For the Teacher

1. Bodmer, R., Book of Wonders. (How gas is made, how steel rails are made.)
2. Spencer, L. J., World's Minerals. Stokes.
3. White, Marian, Fuels of the Household. Whitcomb and Barrows, Boston.
4. U. S. Bureau of Education. Safeguarding the Home against Fire. (Several excellent lessons) Washington, D. C.
5. Bureau of Standards. Materials for the Household. Cir. 70. Washington, D. C. (25c).
6. Bureau of Standards. Safety for the Household. Cir. 75. (15c).

7. Relation of Air to Food Manufacture.

(A) General

1. Toothaker, Charles R., Commercial Raw Materials. Ginn & Co. (Vegetable products, wheat, barley, rye, oats, corn, rice, starch, sugar.)
2. Hopkins and Bond, Scientific American Reference Book. Munn & Co. (Daily food consumption in New York City.)
3. Bodmer, R., Book of Wonders. (How sugar is made from sugar beets.)

(B) Magazines

1. Saccharine as a sugar substitute. Sci. Amer. Sup., April 13, 1918.

(C) Bulletins, etc.

1. Quaker Oats Co., Chicago. Cereal products exhibit.
2. Corn Products Refining Co., New York. Corn products exhibit.
3. Sugar Refining Co., Brooklyn, N. Y. Sugar exhibit.
4. Washburn-Crosby Co., Minneapolis, Minn. Wheat products exhibit.

(D) History

1. New International Encyclopaedia. Dodd, Mead & Co. (Lives of Asa Gray and John Torrey.)

(F) For the Teacher

1. Allen, Nellie B., The United States. (Sugar.)

8. Dusts, Molds, and Bacteria of the Air.

(A) General

1. Conn, H. W., Bacteria, Yeasts, and Molds in the Home. (Suggestions for laboratory experiments.)
2. World Almanac, 1918. (54c.) (New York Department of Health, p. 773.)
3. Hopkins and Bond, Scientific American Reference Book. Munn & Company. (Deaths from consumption, p. 19.)
4. Smallwood, Reveley, and Bailey, Practical Biology. Allyn & Bacon. (Chapter 19, Biology of disease.)

(B) Magazines

1. Anon. A strange botanical garden. (How book molds are studied.) Sci. Amer. April 27, 1918, p. 379.
2. The persistent delusion of ptomaine poisoning. Current Opinion, 54:262, April, 1918.
3. Claycomb, G. B., Petri dish projects. Sch. Sci., and Math., April, 1918.

(C) Bulletins, etc.

1. Fleischmann Co., The Value of Compressed Yeast. Fleischmann Company, 701 Washington Street, New York. (Brief story of compressed yeast.)

(D) History

1. New International Encyclopaedia. Dodd, Mead & Co. (Lives of Metchnikoff, Koch, and Simon Flexner.)
2. Smallwood, Reveley, and Bailey, Practical Biology. (Portraits of Pasteur, Koch. See chapter 23.)

(E) Occupations

1. Vulte and Vanderbilt, Food Industries. Chemical Publishing Co., Easton, Pa. (Chapter 8, Yeast and baking powder.)

(F) For the Teacher

1. Prudden, T. M., Dust and Its Dangers. ($1.00.) Putnam.
2. Buchanan, E. D., Household Bacteriology.
3. Kinne and Cooley, Foods and Household Management. Macmillan Co. (Yeast bread).

9. Distribution of Bacteria and Other Disease Germs.

(A) General

1. Baker, Abby G. and Ware, A. H., Municipal Government of the City of New York. Ginn & Co. (Chapter 10, Department of street cleaning. Chapter 19, Department of health.)
2. Official Handbook, Boy Scouts of America. Doubleday, Page & Co. (Questions on public health, dairying.)
3. Wing, H. H., Milk and Its Products. Macmillan Co.

(B) Magazines

1. Headlee, Thomas J., The mosquito question; the migration question. Sci. Amer. Sup., April 6, 1918, p. 214.
2. Headlee, Thomas J., Effective methods of fly control. Sci. Amer. Sup., March 9, 1918, p. 151.

3. Marvels in the latest antiseptics. Current Opinion, 64:336. May, 1918.
4. Anon. Our Technical Achievements in the Great War. Sci. Amer. Sept. 20, 1919. (Deaths by principal diseases.)
5. Keen, W. W., The Red Cross and the Antivivisectionists. Science. Feb. 22, 1918. (Typhoid and tetanus).
6. Anon. The Prevention and Cure of Hookworm. Sci. Amer. April 5, 1919.

(D) History

1. Radot, Rene V., The Life of Pasteur. Doubleday, Page & Co. (The silkworm disease, typhoid fever, hydrophobia.)
2. New International Encyclopaedia. Dodd, Mead & Co. (Edward Jenner, Joseph Lister, Mayo Brothers.)

(E) Occupations

1. Weaver and Byler, Profitable Vocations for Boys. A. S. Barnes Co. (Page 39, average earnings of street sweepers, hydrantmen, laundrymen, plumbers, fumigaters, etc. of Buffalo.)
2. Same. (pp. 234-241. Medical work.)
3. Gowin, E. B., and Wheatley, W. A., Occupations. Ginn & Co., (Chapter 4, The dairyman.)

(F) For the Teacher

1. Rosenau, M. J., The Milk Question. (Department of health, pasteurization, infant mortality, milk from the farm to consumer.)

PART II. WATER AND ITS USES.

10. Ice, Water, and Steam.

(A) General

1. Black and Davis, Practical Physics. Macmillan Co. (Distillation, thermometers, evaporation, ice machines.)
2. Measurements for the Household. Bureau of Standards, Washintgon, D. C. (15c.) (Refrigerators.)
3. Finch, W. C., and Hawkes, E., Water in Nature. (Romance of Reality Series).
4. Popular mechanics Co., Boy Mechanic. Vol. 2. (How to make a steam turbine, a water wheel, a water motor, as a reaction type steam engine.)

(B) Magazines

1. Hot and Cold Water in the Farm Kitchen. Sci. Amer. Feb. 2, 1918.
2. Siphons, How They Work. Elec. Exp. 5:773. March, 1918.

(C) Bulletins, etc.

1. Catalogues of ice-factory manufacturers.
2. Catalogues of manufacturers of refrigerators.

(D) History

1. Tyndall, John, Faraday as a Discoverer. D. Appleton & Co.
2. Holland, R. S., Historic Inventions. Jacobs.
3. Iles, George, Leading American Inventors. Holt.

(E) Occupation

1. New York Times, Thursday, May 9, 1918. (Wages of all classes of railway employees.)

(F) For the Teacher

1. Ahrens, Harley, and Burns. A Practical Physics Manual. P. Blakiston and Sons, Philadelphia.

11. Mechanical Uses of Water and Air.

(A) General

1. Lynde, C. J., Home Waterworks. Sturgis. (Running water in the home.)
2. Corbin, T. W., Romance of Submarine Engineering. Seeley, Service & Co. (Excellent illustrations.)
3. New York Post, April 20, 1918. (New York fire department: High pressure water system.)
4. Crump, Irving, Boy's Book of Firemen. (New York fire department, high pressure water mains.)
5. Darrow, F. L., The Boy's Own Book of Great Inventions, Macmillan. (The submarine).

(B) Magazines

1. The pneumatic water works. Sci. Amer., May 4, 1918.
2. Cushing, C. P., How much fresh air can a well man stand? World's Work, February, 1917.
3. Pennsylvania railroad's new air brake. Ill. World, October, 1916.

(C) Bulletins, etc.

1. Catalogues of pump manufacturers.
2. Catalogues of firms manufacturing hydraulic barber chairs.

(D) History

1. New International Encyclopaedia. Dodd, Mead & Co. (Life of Archimedes.)
2. Lodge, Sir Oliver, Pioneers of Science. Macmillan.

(E) Occupations

1. Collins, A. F., How to Fly. D. Appleton & Co. (Aviation section requirements and rate of pay.)

(F) For the Teacher

1. Millikan and Gale, Practical Physics. Ginn & Co. (Lift pump hydraulic press, balloons.)

12. Climate Influences of Bodies of Water.

(A) General

1. Harrington, Mark W., About the Weather. D. Appleton & Co. (Chapters 9, 10, 11, 12.)

(B) Magazines

1. Dines, W. H., Meteorology and Aviation, Sci. Amer. Sup. 84: 144. Sept. 1, 1917.
2. Bliss, G. S., Weather Business. Sci. Amer. Sup. 84:110-11, Aug. 18, 1917.

(C) Bulletins, etc.

1. Hints for Health in Hot Weather. Health Ed. League, 8 Beacon Street, Boston.
2. Warm Weather and How to Deal with It. A. H. Doty, 205 West 57th Street, New York.

(F) For the Teacher

1. Cox and Armington, The Weather and Climate of Chicago. University of Chicago Press.
2. Salisbury, R. D., Physiography. Henry Holt and Co. (Chapter 14).

13. Water and Commerce.

(A) General

1. Baker, Abby G. and Ware, A. H., Municipal Government of the City of New York. Ginn & Co. (Chapter 18. Department of locks and ferries.)
2. Rocheleau, W. F., Great American Industries: Transportation. A. Flanagan Co., Chicago. Pp. 50-108. Waterways; history and modern development.)

(B) Magazines

1. Last year's high-water mark in world-trade. Lit. Digest, 54: 143, April 14, 1917.

(C) Bulletins, etc.

1. Protection from Overflow, Mississippi River Levee Assn., Scmitar Building, Memphis, Tenn.

(D) History

1. Thurston, R. H., Robert Fulton, His Life and Its Results. Dodd, Mead & Co., New York.

(E) Occupations

1. Gowin, E. B., and Wheatley, W. A., Occupations. Ginn & Co. (Chapter 11, The civil engineer.)

(F) For the Teacher

1. Talbot, F. A., Lightships and Lighthouses. J. B. Lippincott Co., Philadelphia. (Thirty-three very interesting chapters. Beautifully illustrated.)

14. Water Supply and Sewage Disposal.

(A) General

1. Baker, Abby G., and Ware, A. H., Municipal Government of the City of New York, Ginn and Co. (Chapter 11, Department of Water Supply. Water Supply of New York City, Croton, and Ridgewood systems.)
2. Official Handbook, Boy Scouts of America, Doubleday, Page & Co. (Questions on plumbing.)
3. World Almanac, 1919. (Vital statistics for New York.)
4. Gerhard, W. P., Water Supply of Country Houses. (Author, 40 E. 42nd Street, New York.)

(B) Magazines

1. Grain Alcohol from Garbage, Ill. World, March, 1918.
2. Meeting New York's Insatiable Demand for Water, Sci. Amer. 117:312-313, Oct. 27, 1917.
3. McFadden, F., Question of Fertilizer, Sci. Amer. 116:575. June 9, 1917.

(C) Bulletins, etc.

1. Armstrong, D. B., Public Laundries in America. American City Reprint, December, 1913, 87 Nassau Street, New York.
2. Dunlap, John H., Water Works in 38 Cities in Iowa. 1914. Uni. Extension Div., Uni. of Iowa, Iowa City, Ia. (5c.)
3. The Common Cup. State Board of Health, Richmond, Va.
4. Natural Ice and Public Health. Natural Ice Assn. of America, 116 Nassau Street, New York.
5. Low-Cost Farm Water Works. Conference for Education in the South. 508 McLachlen Bldg., Washington.

(E) Occupations

1. Gowin, E. B., and Wheatley, W. A., Occupations. Ginn & Co. (Chapter 9, The plumber; Chapter 11, the sanitary engineer.)

(F) For the Teacher

1. Prudden, T. M., Drinking Water and Ice Supplies and Their Relations to Health and Disease. Putnam.
2. Vulte and Vanderbilt, Food Industries. Chemical Pub. Co., Easton, Pa. (Chapter 2. Water.)
3. Bureau of Standards. Materials for the household. (Water, soap, cleansing agents.)
4. Roberts, H. A., The farmer his own builder. David McKay, 608 S. Washington Square, Philadelphia.

PART III. WORK, ENERGY, AND ELECTRICITY.

15. Common Types of Work.

(A) General

1. Lynde, John C., Physics of the Household. Macmillan Co. (Chapter 3, Work: Chapters 1, 2, Machines.)
2. Hiscox, Gardner D., Mechanical Appliances. Norman Henley Pub. Co. (Perpetual motion.)
3. World Almanac, 1918. (Seven wonders of the world, p. 477: Epoch making inventions, p. 143: High buildings in New York City, p. 919.)
4. Hopkins and Bond, Scientific American Reference Book. Munn & Company. (Devices to obtain mechanical movement, p. 519.)

(B) Magazines

1. Ten greatest inventors of our time, Sci. Amer., Nov. 1, 1913, p. 337.
2. Sixteen famous modern inventors, Sci. Amer., June 5, 1915.
3. Williams, Archibald, How It Works. Thomas Nelson and Sons, Ltd., New York. (Chapter 20. pp. 410-455. Watches, clocks, and various mechanisms.)
4. Everyday Mechanics Co., Everyday Engineering magazine. (Consult back numbers for good construction problems.) (Address firm at 2 W. 45 Street, New York.)
5. Meccano Co., Meccano Wonder Book and Magazine (10-K, Bush Terminal, Brooklyn, New York.)

(C) Bulletins, etc.

1. Becker & Co., London, Catalogue of Physical Apparatus. (Sec. 5, excellent illustrations of six simple machines.)
2. Knott, L. E., Boston, Catalogue of Physical Apparatus. (Pp. 138-158, illustrations of simple machines.)
3. Central Scientific Co., Chicago, Catalogue. Illustrations of simple machines.)

(D) History

1. Williams, Archibald, Romance of Modern Engineering. Seeley, Service & Co., London. (Chapter 1, Harnessing Niagara Falls.)
2. Burns, E. E., Story of Great Inventions. Harper and Brothers, (Chapter 3, James Watt and the steam engine.)
3. Iles, G., Leading American Inventors Henry Holt & Co.

(E) Occupations

1. Weaver and Byler, Profitable Vocations for Boys. A. S. Barnes Company (Pp. 140-142. Electrical workers.)
2. Gowin, E. B., and Wheatley, W. A. Occupations. Ginn & Co., (Chapter 11, The mechanical engineer.)

(F) For the Teacher

1. Black and Davis, Practical Physics. Macmillan Co. (Chapter 2. Simple machines.)
2. Carhart and Chute, Physics With Applications, Allyn & Bacon, (Chapter 6. Mechanical work, illustrated with 50 cuts.)
3. Bodmer, R., Book of Wonders. (Pulleys on Woolworth Building elevators.)

16. Mechanical Energy and Heat.

(A) General

1. Toothaker, Charles R., Commercial Raw Materials. Ginn & Co. (Coal and petroleum.)
2. Bodmer, R., Book of Wonders. (Story of the building of a great liner: Story in a lump of coal.)
3. Official Handbook, Boy Scouts of America. Doubleday, Page & Co. (Questions on automobiling.)
4. World Almanac, 1919. (Motor vehicles in New York State.)
5. Hopkins and Bond, Scientific American Reference Book. Munn & Co. (Petroleum, p. 88: Energy used in manufacturing in U. S., p. 96: Gas industry, p. 131.)
6. Popular Mechanics Co. The Boy Mechanic. (Designs of steam engines.)

(B) Magazines

1. Ashmead, D. C., The man who mines our coal. Sci. Amer., May 18, 1918, p. 455.
2. The efficient use of coal. Century, February, 1918.
3. Armstrong, C., How much heat is in your coal? Ill. World, 29: 34-35, March, 1918.
4. Anon. America's automobile industry. Sci. Amer. Nov. 22, 1919.

(C) Bulletins, etc.

1. Popular Mechanics. Charts of automobile, steamship, locomotive, gas engine.

(D) History

1. Forman, S. C., Stories of Useful Inventions. Century Co., New York. (The steam engine. Pp. 54-73.)
2. Fournier, E. E., Wonders of Physical Science. Macmillan Co. (Chapter 8, The inventor of the steam engine.)
3. Thurston, R. H., History of the Growth of the Steam Engine. D. Appleton & Co.
4. Carnegie, Andrew, James Watt. Doubleday, Page & Co.
5. Iles, George, Inventors at Work. Doubleday, Page & Co.

(E) Occupations

1. Weaver and Byler, Profitable Vocations for Boys, A. S. Barnes Co. (Pp. 84-91. Average salaries of railroad men and department of docks of New York City.)
2. Same. (Pp. 93-101. Factory work and wages.)
3. Same. (Pp. 220-224. Engineering professions.)
4. Gowin, E. B., and Wheatley, W. A., Occupations. Ginn & Co. (Chapter 6, Steam railroading: Chapter 10, the stationary engineer; the chauffeur.)

(F) For the Teacher

1. Allen, Nellie B., The United States. (Coal.)
2. Smith, J. Russell, Commerce and Industry. Henry Holt & Co. (Use of energy; mineral industries.)

17. Heat and Light from Electric Currents.

(A) General

1. Baker, Abby G., and Ware, A. H., Municipal Government of the City of New York. Ginn & Co. (Chapter 12, Department of Gas and Electricity: Motion-picture theatres.)
2. Official Handbook, Boy Scouts of America. Doubleday, Page & Co. (Questions on electricity and photography.)
3. New York Post, April 20, 1918. (Electric fire hazards in home and office. Underwriters Laboratories.)
4. Bodmer, R., Book of Wonders. (Development of the electric lamp: Story of the magnet, ocean cables, telephones, and telegraph.)
5. Popular mechanics Co. The Boy mechanic. (Designs for lamp flasher, electric toaster, and electric stove.)
6. Bureau of Standards. Safety for the household. (Typical accidents.)

(B) Magazines

1. Electrical Experimenter, January, 1918. (The fire power plant in New York, p. 598: Electric signs in New York, p. 597.)

(C) Bulletins, etc.

1. Monographs B-1, B-2, B-3. Weston Electrical Instrument Co., Newark, N. J. (Free. Simple experiments with excellent diagrams and cuts of electrical instruments.)
2. Lectures on Electrical Apparatus. Monograph B-5. Weston Elec. Ins. Co. (Free. Experiments and explanations for electrical instruments. Excellent illustrations.)
3. Farmer's Electrical Handbook. Western Electric Co. New York. (Catalogue and textbook combined.)
4. Belden Manufacturing Co., Chicago. (Wire, all kinds.)
5. Driver Harris Wire Co., Harrison, N. J. (Resistance wires.)
6. Electric Ware Catalogue. Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa.
7. Inventor and the Lamp. (Lecture 8.) General Electric Lecture Service, Schnectady, New York.
8. Evolution of Electric Lighting. (Lecture 8.) G. E. L. S.
9. Commercial Electric Heating and Cooking. (Lecture 7.) G. E. L. S.

(D) History

1. New International Encyclopaedia. Dodd, Mead, & Co. (Galvani, Volta, Watt, Ampere, Ohm, and Edison.)
2. George Simon Ohm, Elec. Age, March, 1916.
3. Andre Marie Ampere, Elec. Age, February, 1916.

(E) Occupations

1. Gowin, E. B., and Wheatley, W. A., Occupations. Ginn & Co. (Chapter 9, The practical electrician.)
2. McCullough, E., Engineering as a Vocation. David Williams Co. (The work, education, and pay of the engineer. Chapters 1, 2, 3, 6.)

(F) For the Teacher

1. Croft, Terrell, Wiring for Light and Power, McGraw Hill Book Company.
2. Hawkins, Electrical Guide. (Vol. 4 and Vol. 10.) Theo. Audel & Co., 72 Fifth Avenue, New York.

18. Chemical Effects of Electric Currents.

(A) General

1. Monograph B-5. Weston Electrical Instrument Co., Newark, N. J. (Experiments on copper plating.)
2. Official Handbook, Boy Scouts of America. Doubleday, Page & Co. (Questions on mining and chemistry.)

(B) Magazines

1. Making Nickel Tube Electrolytically. Scientific American, March 15, 1913, p. 239.

(C) Bulletins, etc.

1. Electro Importing Co., New York. Catalogue. (Plating outfits for amateur work.)
2. Frederick B. Stevens, Detroit. Catalogue. (Commercial plating outfits.)
3. Edison Alkaline Storage Battery. Edison Storage Battery Co., Orange, N. J. (Free bulletin for schools, well illustrated.)
4. Development of the Electrical Industry. (Lecture 14.) General Electric Lecture Service, Schnectady, N. Y.

(D) History

1. Michael Faraday, Elec. Age, April, 1916.
2. Lord Kelvin, Elec. Age, July, 1916.

(E) Occupations

1. Weaver and Byler, Profitable Vocations for Boys. (Page 120. Annual earnings of platers, engravers, and electrotypers.)
2. Gowin, E. B., and Wheatley, W. A., Occupations. Ginn & Co. (Chapter 11, The electrical engineer: Chapter 13, The electrotyper.)

(F) For the Teacher

1. Page, Victor W., Storage Batteries Simplified. Norman W. Henley Pub. Co., New York.
2. Bedell, W. L. D., Practical Electroplating. (Pub. by author, Springfield, Mass.)
3. Hawkins, H. J., Polishing and Plating of Metals. Hazlitt and Walker, Chicago.

19. The Magnetic Effects of Electric Currents.

(A) General

1. Baker, Abby G. and Ware, A. H., Municipal Government of the City of New York. Ginn & Co. (Chapter 15, Subway and electric railways.)
2. World Almanac, 1918. (Telegraph rates, p. 918.)
3. Hopkins and Bond, Scientific American Reference Book. Munn & Co. (Telegraphs and cables, p. 279: Telephone statistics, p. 311.)

(B) Magazines

1. Fleming, J. A., Our Useful Servants: Magnetism and Electricity. Sci. Amer. Sup., Feb. 23, 1918.
2. Large Electromagnet. Sci. Amer. Sup., Jan. 26, 1918.
3. Claudy, C. H., Romance of invention I. (Bell and the telephone.) Sci. Amer., July 19, 1919.

(C) Bulletins, etc.

1. Jameson, P. R., The Compass, The Signpost of the World. Taylor Instrument Company, Rochester, N. Y.
2. Electrical Supply Catalogue. Manhattan Elec. Supply Co., New York.
3. Stanley and Patterson Catalogue. Stanley & Patterson Co., New York.

4. Small Motors and Generators, Catalogue. Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.
5. Sears Roebuck & Co., Chicago, Electrical Goods Catalogue.
6. The electric motor—construction and application. (Lecture 20.) General Electric Co. Lecture Service, Schenectady, New York.
7. The electric fan motor. (Lecture 13.) G. E. L. S.

(D) History

1. New International Encyclopaedia. Dodd, Mead & Co. Henry, Morse, Oersted, Tesla, Pupin, J. J. Thompson, and Lord Kelvin.)
2. James Clerk Maxwell. Elec. Age, June, 1918.
3. Joseph Henry. Elec. Age, May, 1916.
4. Silvanus P. Thompson, Elec. Age, August, 1916.

(E) Occupations

1. Bloomfield, Meyer, Youth, School, and Vocation. Houghton Mifflin Co. (Electrical work.)
2. Gowin, E. B., and Wheatley, W. A., Occupations. Ginn & Co., (Chapter 6. Electric railroading. See p. 138 also.)
3. Electrical World, April 27, 1918. (Government wages of electrical men, p. 869. List of special trades with wages.)

(F) For the Teacher

1. Cook, Arthur L., Interior Wiring. John Wiley and Sons. New York. (Good on modern methods.)
2. Timbie, W. H., Elements of Electricity. John Wiley and Sons.
3. Hawkins, Electrical Guide. (Vol. 2 and Vol. 3.) Theo. Audel & Co., 72 Fifth Avenue, New York.
4. Popular mechanics Co. The Boy Mechanic (Designs for ammeter, annunciator, bell-ringing, transformer, electric motor, voltmeter, and shocking coil.)

PART IV. THE EARTH IN RELATION TO OTHER ASTRONOMICAL BODIES.

20. The Moon, Planets, and Comets.

(A) General

1. McKready, Kelvin, A Beginner's Star Book, G. P. Putnam's Sons. (Chapter 5, The solar system and moon. Forty very fine illustrations.)
2. World Almanac, 1918. (Astronomy, p. 53.)
3. Lewis, Mrs. Isabel M., astronomy. Duffield and Co., New York.

(B) Magazines

1. See first issue of Scientific Amer. for this month.
2. Evening Sky Map, Leon Barritt, 150 Nassau Street, New York. (Monthly magazine, $1.00 per year. Gives excellent sky map for current month.)
3. Lewis, Isabel M., Popular astronomy. Elec. Exp. December 1918. (See also Jan., April, March, May and Sept. 1919 issues.)
4. Anon. How far away is the moon? Sci. Amer. Dec. 20, 1919.
5. Holmer, C. N., Why are lunar eclipses visible? Sci. Amer., Nov. 22, 1919.
6. Anon. Mount Wilson's 100 inch reflector monthly. Evening Sky Map, May 1919.

(C) Bulletins, etc.

1. Barritt, Leon, The Barritt-Serviss Star and Planet Finder. Leon Barritt, 150 Nassau Street, New York. (Very simple and useful chart, $3.00.)

2. Alvan Clark and Sons Corporation, Catalogue. Cambridgeport, Mass. (Telescopes.)
3. Lohmann Bros., Catalogue. Greenville, Ohio. (Telescopes.)

(D) History

1. New International Encyclopaedia. Dodd, Mead & Co., (Kepler, Galileo, Newton, Halley, and Roemer.)

(F) For the Teacher

1. Price, Edward W., The Essence of Astronomy. G. P. Putnam's Sons. (Solar system, moon, comets, and instruments.)
2. Flammarion, Camille, Astronomy. Doubleday, Page & Co. (Phases of the moon, plan of the solar system.)
3. Serviss, G. P., The Moon. D. Appleton & Co., (Gives 21 excellent photographs of the moon.)
4. Moulton, Forest Ray, An Introduction to Astronomy. Macmillan Co.

21. The Sun and Other Stars.

(A) General

1. McKready, Kelvin, A Beginner's Star Book. G. P. Putnam's Sons. (Chapters 1, 2, 3, 4, and 6. Stars, etc., and instruments for amateurs.)
2. Hopkins and Bond, Scientific American Handbook. Munn & Co. (Star maps for year.)
3. Official Handbook, Boy Scouts of America. Doubleday, Page & Co. (Questions on astronomy.)
4. Olcott, W. T., In Starland with a Three Inch Telescope. G. P. Putnam's Sons.
5. Campbell and others, The Adolf Stahl Lectures on Astronomy. (Address Leon Barritt, 150 Nassau St., New York.)

(B) Magazines

1. Showalter, W. J., Exploring the glories of the firmament, National Geographic Magazine, Aug. 1919.
2. Veronnet, Alex, Physical constitution of the sun. Sci. Amer. Sup. Dec. 28, 1918.
3. Butler, Howard R., Painting the solar corona. Natural History magazine, March 1919.

(C) Bulletins, etc.

1. Catalogue. W. and D. Mogey, Interhaven Avenue, Plainfield, N. J. (Telescopes.)
2. Catalogue. John A. Brashear Co., Ltd. Pittsburg, Pa. (Telescopes.)
3. Central Scientific Co., Chicago. Catalogue. (Lantern slides on astronomy and astronomers.)
4. University of Chicago. Catalogue, Astronomical Photographs, April, 1911. Address University Press.

(D) History

1. New International Encyclopaedia, Dodd, Mead & Co. (Pickering, Lowell, Hale, Campbell, and Michelson.)

(F) For the Teacher

1. Chambers, George F., Astronomy. Hutchinson & Co., London. (Comets, nebulae, and constellations, fine colored illustrations.)
2. Burgel, Bruno H., Astronomy for All. Cassell & Co., London (Lick and Yerkes observatories.)
3. Serviss, G. P., Astronomy with the Naked Eye. Harper and Brothers. (Constellations visible each month.)
4. Olcott, William T., Star Lore of All Ages. G. P. Putnam's Sons. (Excellent illustrations.)

PART V. THE EARTH'S CRUST.

22. How Rock Becomes Soil.

(A) General

1. Van Hise, Charles R., Conservation of Natural Resources in the U. S. (Mineral production.)
2. Hopkins and Bond, Scientific American Reference Book. Munn & Co. (Mineral products of the U. S., p. 77; production of gold, silver, iron, copper, tin, p. 79-82; salt, p. 93; cement p. 91.)
3. Smith, J. Russell, Commerce and Industry. Henry Holt & Co. (Basic metals: Mineral industries.)

(B) Magazines

1. Brooks, B. Drainage to prevent erosion. Sci. Amer. Sup. 82: 45, July 15, 1916.
2. Land that runs away. Lit. Digest, 52:1696, June 10, 1916.

(D) History

1. Russell, I. C., Glaciers of North America. Ginn & Co. (Describes beginning, development, and decay of glaciers.)

(F) For the Teacher

1. Lyon, T. L., Soils: Their Properties and Management. Macmillan Company.
2. Salisbury, R. D., Physiography. Henry Holt & Co.
3. Ford, William E., Dana's Manual of Mineralogy. John Wiley and Sons. (List of minerals for small collection.)
4. Whitson, A. R., Soils and Soil Fertility, Webb Publishing Co. St. Paul, Minn.

23. Physical Structure and Fertility of Soil.

(A) General

1. Bodmer, R., Book of Wonders. (How glass is made.)
2. Clute, Agronomy, Ginn & Co. (Chapter 3, types of soils.)
3. Hopkins and Bond, Scientific American Reference Book. Munn & Co. (Clay products of the world, p. 75: Glass industry, p. 120.)

(B) Magazines

1. Rockwell, F. F., Prepare for bigger crops next year. Country Life, 32:54-5.
2. Future fertilizer supplies and requirements. Sci. Amer. 116: 449, May 5, 1917.
3. National manure pile of Germany as the decisive factor of the war. Current Opinion. 62:104-5, February, 1917.

(C) Bulletins, etc.

1. Morris & Co., Chicago. Fertilizer exhibit.
2. Swift & Co., Chicago. Fertilizer exhibit.
3. Zerecki Chemical Co., Sandusky, O. Fertilizer exhibit.
4. Hopkins, C. G., Illinois system of permanent agriculture. Cir. No. 167. Uni. of Ill. Agri. Exp. Station, Urbana, Ill.
5. Fippin, Elmer O., Program of soil improvement for New York State. Cornell Extension Bulletin.
6. Fippin, Elmer O., Introduction to principles of soil fertility. Cornell reading course. Vol. 14, No. 74.

(E) Occupations

1. Sanford, A. H., Story of Agriculture in the United States. D. C. Heath & Co. (Chapter on department of agriculture.)
2. Gowin, E. B., and Wheatley, A. W., Occupations. Ginn & Co., (Chapter 4, Agriculture and allied occupations.)

(F) For the Teacher

1. Hopkins, C. G., Soil Fertility and Permanent Agriculture. Ginn & Co.
2. Hall, A. D., The Soil. Dutton.
3. Mosier and Gustafson, Soil Physics and Management. J. B. Lippincott Co.
4. King, F. H., The Soil. Macmillan.

24. Soil, Water, Drainage, and Irrigation.

(A) General

1. Waters, Henry W., Essentials of Agriculture. Ginn & Co.
2. Price, O. W., The Land We Live In. Small, Maynard & Co. (Chapter 8. The rivers.)

(B) Magazines

1. Killick, V. W., Damming Cloudbursts for Irrigation. Ill. World, 26:404-5, November, 1916.
2. How the farmer can avert the danger of floods. Cur. Opinion, 62:61, January, 1917.

(C) Bulletins, etc.

1. International Harvester Co., Chicago. Demonstration charts.
2. Scofield and Farrell, Agriculture on government reclamation projects. U. S. Agriculture Dept. Year Book, 1916.
3. Fippin, E. O., Soil moisture and crop production. Cornell reading course. Soil series No. 4.
4. Fippin, Elmer O., Land drainage and soil efficiency. Cornell reading course. Soil series No. 5.

(D) History

1. Bond, A. R., On the Battlefront of Engineering. Century Co. 1916. (Harnessing Thunder River.)
2. Marriott, C., Uncle Sam's Business. Harper & Bro. (Chapter 37. Irrigation.)

(E) Occupations

1. Weaver and Byler, Profitable Vocations for Boys. A. S. Barnes Co. (Pp. 256-261. Country occupations.)

(F) For the Teacher

1. King, F. H., Irrigation and Drainage. Macmillan. (Relation of water to soils and plants.)
2. Widtsoe, J. A., Principles of Irrigation Practice. Macmillan.

25. Erosion and Sedimentation.

(A) General

1. Price, O. W., The Land We Live In. Small, Maynard & Co. (Chapter 4, Forest fires and their effects.)
2. Fairbanks, H. W., Rocks and Minerals. Educational Pub. Co., New York. (Chapters 1-4.)

(B) Magazines

1. Frances, Henry R., Selecting Trees for Shelter, Shade, and Show. Amer. For. January, 1918.
2. Adams, Bristaw, Paying for Pine Trees. Amer. For. 24:36-37, January, 1918.
3. Dahl, Arthur, Trees for the desert. Sci. Amer. Sup., March 22, 1919.
4. Drake, W. A., The Miami conservancy flood prevention plan. Sci. Amer., March 22, 1919.

5. Claudy, C. H., Economic tree murder. Sci. Amer. August 9, 1919.

(C) Bulletins, etc.

1. Pinchot, Gifford, A Primer of Forestry. Government Printing Office, Washington.

(D) History

1. New International Encyclopaedia. Dodd, Mead & Co. (Dana and Le Conte.)
2. Bolton, S. K., Famous Men of Science. T. Y. Crowell & Co., New York. (Agassiz.)

(F) For the Teacher

1. Salisbury, R. D., Physiography. Henry Holt & Co. (Chapter 3, The work of ground water. Chapter 4, Work of running water.)
2. Recknagel, A. and John Bentley. Forest management. John Wiley and Son.

26. Life in the Soil.

(A) General

1. Roth, Filibert, First Book of Forestry. Ginn & Co. (Use of forest and how to distinguish common trees.)
2. Cobb, Ernest, Garden Steps. Silver Burdett & Co. (Fertilizers, sprays, poisons, tools, canning, and drying.)

(B) Magazines

1. Schufeldt, R. W., Studies of Leaf and Tree. Amer. Forestry, January, February, and March, 1918.

(E) Occupations

1. Lawson, W. P., Log of a Timber Cruiser. Duffield. (Work of forester in New Mexico.)
2. Harwood, W. S., New Creations in Plant Life: Life and Work of Luther Burbank. Grosset and Dunlap.
3. Pinchot, Gifford, Training of a Forester. Lippincott. (Opportunities of forest service, and training required.)

(F) For the Teacher

1. Gifford, J. C., Practical Forestry for Beginners, Agricultural Students, and Woodland Owners. Appleton.
2. Price, Q. W., The Land We Live In. Small, Maynard & Co. (Chapter 3, How the forest is used at home and abroad.)

PART VI. LIFE UPON THE EARTH.

27. The Plant Covering of the Earth.

(A) General

1. Toothaker, Charles R., Commercial Raw Materials. Ginn & Co. (Manila hemp, sisal hemp, flax, linseed oil, hemp, jute, cocoanut palm, cotton, paper, artificial silk, yellow pine, spruce, cypress, poplar, maple, oak, cork, distillation of wood, gums, resin, rubber.)
2. Bodmer, R., Book of Wonders. (How paper is made.)
3. Hopkins and Bond, Scientific American Reference Book. Munn & Co. (Paper industry, p. 126: Books published, p. 124.)
4. Official Handbook, Boy Scouts of America. Doubleday, Page & Co. (Questions on agriculture and conservation.)
5. Bodmer, R., Book of Wonders. (How automobile tires are made from rubber.)

(B) Magazines

1. Bastin, S. L., Touring Plants. Sci. Amer., 117:228, Sept. 29, 1917.

2. Bastin, S L., Power of growth in plants. Sci. Amer. Sup., 82:412, Dec. 23, 1916.
3. Moon and plant-growth. Lit. Digest, 55:27, Sept. 8, 1917.
4. Burns, Findley, Publications of forest service classified for teachers and students. School Science and Mathematics, Nov. 1918.

(C) Bulletins, etc.

1. Department of Interior, Washington, D. C. Glimpses of our National Parks.
2. International Harvester Co., Chicago. Harvest scenes of the world.
3. Hoosier Sheeting Co., Cannelton, Ind. Cotton products exhibit.
4. Tennessee Cotton Oil Co., Memphis, Tenn. Cotton products.
5. White Oak Cotton Oil Mills, Greensboro, N. C. Cotton products.
6. Linen Thread Co., New York. Linen exhibit.
7. McCormick Twine Co., Chicago. Hemp exhibit.
8. Butler Paper Co., Chicago. Paper exhibit.
9. Corticelli Silk Mills, Florence, Mass. Silk exhibit.

(D) History

1. Bolton, S. K., Famous Men of Science. T. Y. Crowell & Co., New York. (Linnaeus, Cuvier, Darwin and Audubon.)

(E) Occupations

1. Weaver and Byler, Profitable Vocations for Boys. A. S. Barnes Co. (Page 267. Manufacturing industries.)

(F) For the Teacher

1. Dooley, M. H., Textiles. D. C. Heath. (Processes of manufacturing wool, silk, cotton, linen goods. Methods of testing.)
2. Heller and Bishop, Commercial and Industrial Geography. Ginn & Co., (Page 246. Cotton products.)

28. How Food Is Used By Plants.

(A) General

1. Smallwood, Reveley, and Bailey, Practical Biology. Allyn and Bacon. (Chapter 20, The bean and corn plant.)

(B) Magazines

1. Dahl, Arthur L., Drying Vegetables. Sci. Amer. Sup., March 2, 1918.
2. Maxim, Hudson, The Soya Bean. Pop. Sci. Mo., May, 1918.
3. Hopping, Aleita, Diffusion, osmotic pressure, and imbibition in high school biology. School Science and Mathematics, May and June 1919.

(C) Bulletins, etc.

1. Bailey, E. H. S., Some Simple Kitchen Tests to Detect the Adulteration of Foods. State Board of Health, Topeka, Kan.

(D) History

1. New International Encyclopaedia. Dodd, Mead & Co. (Life of W. Pfeffer.)
2. Clodd, Edward, Pioneers of Evolution, from Thales to Huxley. Appleton, New York.

(F) For the Teacher

1. Hall, A. D., Fertilizers and Manures. Dutton.
2. Wheeler, H. J., Manures and Fertilizers. Macmillan.

29. The Utilization of Food in Animals.

(A) General

1. Farmer, A. N., and Huntington, J. R., Food Problems. Ginn & Co. (Food situation in Europe; wheat, meat, butter, milk, and sugar problems for class use. Cost of war.)
2. Toothaker, Charles R., Commercial Raw Materials. Ginn & Co. (Tea, coffee, cocoa, mustard, pepper, cloves, nutmegs, vanilla, ginger, cinnamon.)
3. Rowely and Farrell, Principles of Chemistry Applied to the Household. Boston Cooking School Co. (Chemistry of foods.)

(B) Magazines

1. Peanuts as food, Lit. Digest, April 13, 1918.
2. Fisk, E. L., Alcohol and human efficiency. Atlantic Monthly, 119:203-10. February, 1917, see also January and March, 1917.
3. Alcohol, its use and abuse. Outlook, 117:285, Oct. 24, 1917.

(C) Bulletins, etc.

1. Bigelow and Howard, Some forms of food adulteration. Bull. 100, 1911. Gov. Printing Office, Washington, D. C.

(D) History

1. New International Encyclopaedia. Dodd, Mead & Co. (Life of Harvey.)

(F) For the Teacher

1. Rose, Mary S., Feeding the Family. Macmillan Co. (Food tables and composition of human body.)
2. Vulte and Vanderbilt, Food Industries. Chem. Pub. Co., Easton, Pa. (Chapter 9, Starch: Chapter 10, Sugar: Chapters 17 and 18, Milk.)
3. Hawk, Philip B. What we eat. Harper and Brothers.

30. Hygienic Aspects of Nutrition.

(A) General

1. Ritchie, John W., Sanitation and Physiology. World Book Company. (Chapters 7, 8, 9, Foods and digestion.)
2. Vulte and Vanderbilt, Food Industries. Chem. Pub. Co., Easton, Pa. (Chapters 19, 20, Preservation of foods.)
3. Keller and Bishop, Commercial and Ind. Geography Ginn & Co. (Source of milk for New York City.)

(B) Magazines

1. U. S. Food Commission, Food for All. (Illustrated by numerous photographs and graphs.) Sci. Amer., April 6, 1918, p. 310.
2. Relation of alcohol to fatigue. Current Opinion, 64:39, January, 1918.
3. Transeau and Stoddard, Alcohol in every-day life. Scientific Temperance Federation, 23 Trull Street, Boston.

(C) Bulletins, etc.

1. Walter Baker Co., Milton, Mass. Chocolate exhibit.
2. Joseph Burnett, Boston, Mass. Flavoring extract exhibit.
3. Diamond Crystal Salt Co., St. Clair, Mich. Salt exhibit.
4. Ice cream soda and soft drinks. State food commission, 1627 Manhattan Bldg., Chicago. (Also booklet on ice cream.)

(F) For the Teacher

1. Sherman, Henry C., Food Products. (Food legislation; sugar, syrups, confectionery; Food and Drugs Act. Appendix A.)

2. Sadler, William, Science of Living. (Alcohol, breathing, food, and adulteration of food.)
3. Freeman and Chandler. World's Commercial Products. 1908. Ginn & Co.

31. Reproduction in Plants and Animals.

(A) General

1. Toothaker, Charles R., Commercial Raw Materials. Ginn & Co. (Animal products, horses, cattle, leather, swine, sheep, wool, insects, silk cocoon, honey bee, birds.)
2. Bodmer, R., Book of Wonders. (Story of wool in a suit. The silk cocoon and the honey bee.)
3. World Almanac, 1918. (54c.) (Canada migatory bird treaty, index.)

(B) Magazines

1. Bigelow, Edward F., How bees produce honeycomb, Ill. Guide to Nature, 10:259-272, February, 1918.

(C) Bulletins, etc.

1. Department of Agriculture, Washington, D. C. (Lantern slides loaned on cattle, horses, and poultry.)

(D) History

1. Lacy, Wm. A., Biology and Its Makers. Henry Holt.

(E) Occupations

1. Gowin, E. B. and Wheatley, A. W., Occupations. Ginn & Co. (Chapter 4, The poultryman.)
2. Phillips, E. F., Beekeeping. Macmillan.
3. Robinson, J .H., Poultry Culture. Ginn & Co.

(F) For the Teacher

1. Dickerson, M. C., Frog Book. Doubleday, Page & Co.
2. Bailey, L. H., Evolution of Our Native Fruits. Macmillan.
3. Stokes, A. C., Aquatic Microscopy for Beginners. John Wiley and Sons.
4. Hornaday, W. T., American Natural History. Charles Scribners.

32. The Struggle for Existence.

(A) General

1. Herrick G. W., Insects Injurious to the Household and Annoying to Man. Macmillian. (Flies, fleas, ants, etc., etc.)
2. Sanderson, E. D., Insect Pests of Farm, Garden, and Orchard. John Wiley and Sons.

(B) Magazines

1. Bouvier, F. L., Wars of Insects. Sci. Amer. Sup., May 4, 1918, p. 274.

(C) Bulletins, etc.

1. Hinds, W. E., Carbon Disulphide as an Insecticide. Farmers Bulletin 799. Government Printing Office.
2. Carbon Bisulphide as an Insecticide. Independent Chemical Co., 72 Front Street, New York.

(D) History

1. New International Encyclopaedia. Dodd, Mead & Co. (Life of Audubon.)
2. Herrick, Francis H., Audubon the Naturalist. D. Appleton & Co. (2 vol.)

(E) Occupations

1. The Management of Bees in Double-Walled Hives. A. I. Root Co., Medina, Ohio.
2. Strawberry Handbook. German Kali Works. McCormick Building, Chicago.

(F) For the Teacher

1. Weed, C. M., Farm Friends and Farm Foes. D. C. Heath & Co. (Fungi, weeds, insects, birds, mammals.)
2. Blanchan and Burroughs, Bird Neighbors. Doubleday, Page & Co. (Beautiful illustrations of most of the common birds.)
3. Blanchan, Nature's Garden. (Flowers and insects.)

33. Parent and Offspring.

(A) General

1. Smallwood, Reveley, and Bailey, Practical Biology. Allyn and Bacon. (Chapter 11, Amphibians; Chapter 13, Birds.)
2. Eggeling and Ehrenberg, Freshwater Aquarium and Its Inhabitants. Henry Holt & Co.
3. World Almanac, 1918. (54c.) (Science progress in 1917, p. 704.)
4. Edgar, W. C., Story of a Grain of Wheat. Appleton.

(C) Bulletins, etc.

1. Dublin, Louis E., The Significance of the Declining Birthrate. Congressional Record. Jan. 11, 1918. (Vital statistics for France, England, Germany, and United States.)

(D) History

1. New International Encyclopaedia. Dodd, Mead & Co. (Burbank, Galton, Mendel, and Osborn.)
2. Poulton, Edward B., Charles Darwin. Macmillan Co.

(E) Occupations

1. Holden and Waggoner. Seed Corn, Do You Know That It Will Grow? International Harvester Co., Harvester Bldg., Chicago. (Also "The Golden Stream" on dairying.)
2. The Childhood of Fruit Trees. Greening Nursery Co., Monroe, Michigan.

(F) For the Teacher

1. Furneaux, W., Life in Ponds and Streams. Longmans, Green & Co. (The collector's work, aquaria, and their management.)

Shop General Science

In the Oakland (California) Technical High School, Mr. Percy E. Rowell is teaching industrial science to supplement the shop work under the provisions of the Smith-Hughes bill. The course is called "Shop General Science." It includes chiefly physical science material particularly adapted to the shop in which the class is working.

General Science From the Point of View of an English Teacher

R. R. Smith, School of Engineering of Milwaukee.

In this article I shall attempt to develop two assertions: (1) General science should be taught to all students in our schools, and it should be begun not later than the fourth schools, and it should not be begun not later than the fourth year of the elementary school; (2) the fundamental principle which is at the bottom of the teaching of general science applies just as effectually to other subjects, and when the teaching of them is placed upon this basis we shall have men and women who do keener thinking.

Some of my friends who teach science will immediately ask: "What justification has this man, a mere teacher of English, for writing an article on general science?" It is right that they should ask that question; and it is right that I should answer it before I proceed to develop the main trend of my article. My answer is that I have a better perspective from which to write such an article than a teacher of science can possibly have. In all likelihood every science teacher has specialized in some one science; from what I can gather of the situation this is true even of the teachers of general science themselves, for they are not yet a separate group but are a group each more or less specialized in some one science such as chemistry or physics or geology. Practically all books till now published on the subject bear me out in this assumption. One is devoted in the main to physics, another to chemistry, and still another to physiography or physical geography; each is in reality an elementary textbook in that particular subject and just has a few facts and experiments along other lines thrown in for good measure. They are most of them very excellent books but they are not books on general science.

Perhaps I can now do no better than be absolutely specific even though I must be guilty of the bad taste of being personal. In the course of my grade school, my high school, and my college and university education I studied at one time or another the following sciences: Physiology, physics, physical geography, chemistry, botany, zoology, anatomy. I believe that the permanent good which I have as a result of having studied

those sciences is the good that we should expect each boy and girl to gain from the study of general science. I remember only the fundamentals, of course. I have no special knowledge of physiology, though at one time I was interested enough in the subject and showed enough promise in the study of it to cause a university professor to ask me to major in it and to offer me a fellowship as an inducement; and with each of the other sciences this is true. Only the fundamentals remain in my mind.

But these fundamentals are at my service. They add interest to my reading. They give me a basis for judging the truth or falsity of statements made. Above all I have taken from the study of the sciences a respect for truth, a respect that mathematics did not give me, and a respect that the church did not give me.

I have learned to believe that the world and the universe are law-governed not chance governed. I have come to see that almost nothing is impossible to the person who will start with an effect and go back to the cause. This, then, is my justification, as a teacher of English, for writing an article on general science. Through dealing with no one science in a narrow specialized way but through daily application of the fundamental scientific truths I have learned, I think I have a broad enough view to enable me to discuss the subject from a more correct perspective than a specialized science teacher.

Now, that I have given my reasons for venturing upon this forbidden ground, I shall go back to the first of my two assertions and discuss it in the light of what I have said.

Why should general science be taught to all students in our schools?

General science should be taught to all students in our schools because in no other way can the boys and girls who are to become our men and women be led to see that the world is based on absolute physical law. Make a child realize once and for all that by placing his hand against a hot stove he will get burned, that by jumping off a high building he will get hurt, and make him see the laws back of these facts and you have him turned toward a reasonable manner of dealing with events and happenings which come to him. Very early in his career he will realize that man can be master of nature but only in

one way, i. e. by the study of nature's laws. This all sounds very simple, and it is; but realization of it comes only after many repetitions. If we stop to think that the world had existed many ages before men began to observe the simple happenings of nature and reason back to the causes of them, we shall realize that only by teaching over and over again the fundamentals of natural laws and as constantly dwelling on the cause and effect of the proposition can we hope to make of our boys and girls, men and women who can reason in straight lines from these effects back to the causes.

I have said that the proposition is very simple; and I fully believe that it is. Fundamental laws are always very simple; so simple that children can be led to understand them. It is true that to take any subject and go into the research fields we may find complications which only an Edison or a man of like calibre can keep in mind. But even the complications of these fields are usually magnified for one reason or another. At least it has always seemed to me as if there were for some reason or other an attempt to make perfectly simple things seems difficult; but I am convinced that it is entirely possible to make all the fundamental natural laws so simple in their explanation that a child can understand them.

That brings me to my next point. Not only is the understanding of natural laws simple, but reasoning in itself is simple, so simple that our treatment of it as if it were very complicated is a crime. Just as essential as learning natural laws is the learning of the scientific method or the inductive method of reasoning as it is sometimes called. We have always used this to a certain extent; but the trouble is that beyond a few general conclusions such as that the sun rises in the east and that man is mortal we have been rather prone to reach false conclusions, and we have been prone to reach them for the reason that we did not observe enough instances before "jumping to conclusions." By such observations great numbers of superstitions grew up in every country; a few of them, at least, remain. It will not be difficult for the reader to find among the people in his neighborhood a few who believe that that the hooting of an owl over one's window presages death for some member of the family. Why? Because, as common as owls are it is not difficult to find one or two instances in which an owl was known to hoot before some person's death. But you

and I know that owls hoot many many times with no dire results.

In my own experience I remember that just before the death of my baby sister, one evening about nine o'clock, we were starteled by what seemed to be the ringing of a neighbor's dinner bell. We rushed outside thinking that there was a fire. Outside we could not hear the bell. As soon as we got back inside the house we could hear it again. We kept going out and in for more than fifteen minutes but we could not find an explanation for the ringing; finally it ceased as suddenly as it began, but to this day the incident remains unexplained and wierd in my memory. I can readily understand how a person who had had no scientific training at all might thoroughly believe that the ringing of that bell foretold my sister's death; as far as I am concerned I do not know inductively that it did not. It has not been so very long ago since we executed witches in this country; and the conclusion that they were guilty was reached by faulty inductive reasoning. Faulty inductive reasoning is still going on and can be combated only by substitution of inductive reasoning less faulty. I believe that this is the most important work which our schools can do for the boys and girls who are to be the men and women of tomorrow.

Training in deductive reasoning is important also. Combined we may say that all that our schools may hope to do is to give students thorough training in inductive and deductive reasoning; but unconsciously people reason in a pretty straight line as far as deductive reasoning is concerned. However, they can be taught the science of it. They can be taught to see that all their thinking, once the general conclusion is reached, is based on this; and knowing that all reasoning is based on this one process will make them better able to analyze and judge their thinking. I have said that all boys and girls should be taught general science and that the study should be begun not later than the fourth year. I think that ALL should be spelled with capital letters; and I am not sure that general science in a very simple form cannot be begun even before the fourth year. In reality the Montessorri system is only general science in an elemental form, and the big training that the Montessorri child gets is training inductive and deductive thinking.

I am now ready to defend my second assertion: *The fundamental principle which is at the bottom of the teaching of general science applies just as effectually to other subjects, and when the teaching of them is placed on this basis we shall have men and women who do keener thinking.* As I have already shown that the one task of general science is the teaching of men and women to reason inductively and deductively with correctness, I may now say that it is the business of every other subject in the curriculum to contribute to the same end.

What about my own subject, English?

I am sorry to say that there has always been a sort of tendency on the part of science and mathematics teachers to "look down" upon English as something really not worthy the consideration of grown-up red-blooded men. This has been true in colleges and in high schools as well.

But while it has been true, there has always been one phase of the English work marked as an exception. This is public speaking.

Why?

Because public speaking was based upon correct inductive and deductive reasoning. When a boy took public speaking and debating he found that English expression which in his other composition courses was more or less of a hodgepodge, a something so complicated and indefinite that it was not possible to find a beginning or end unless you were one of the fortunate few who wrote "by feeling," and there are such people, of course. Those who doubt this statement concerning composition, have only to take down a book of public speaking and compare it with the average rhetoric to convince themselves of its truth. I think that I have been more miserable trying to use rhetoric books than I have from any other one cause. To this day when I attempt to follow out the directions of a rhetoric I do not succeed in teaching my students to write.

Why?

Because they do not start out with the simple assumption that all reasoning must be either inductive or deductive. They begin with some minor detail, and most of them never even reach the main point at all. One will begin with punctuation; another will begin with description; another will begin with exposition; just anything that will be different from the other fellow and so justify the placing of a new book on the market.

But the new book is hailed with joy for teachers all over the country are floundering and it is adopted by many schools. However just watch its course for a few years. It goes the way of its fellows; for it has not been based on fundamental inductive and deductive reasoning.

But this is destructive, not constructive discussion. Our English course should reinforce the science course in two ways. It should train the student to read not only his scientific texts but other books as well; it should train the student to express himself. These are very trite statements, I realize, but they will seem less so when I explain that such reading and such expression become merely the interpreting of inductive or deductive reasoning in some form or the expressing of inductive or deductive truths in some form. Correct expression is a matter of correct thinking; and let us not forget that we have already said that correct thinking is not complicated but simple.

We hear much of making English practical. It in common with all subjects is being asked to demonstrate its right to be. It is well that such is the case. Man is placed in a law-ruled world. In proportion as he finds out the laws that govern this world he progresses or fails to progress. Not only is he placed in a law-ruled world but he is placed in a world that is made happy for him each day by thousands of sensations coming to him through one or all his five senses. Just as the laws can be learned and applied to life inductively and deductively the sensations can be studied and revelled in and appreciated. Literature is only a record of these sensations or in some cases an interpretation of these sensations in such a manner as to give the reader the pleasure he gains from them when the original causes of them are not present. Literature suggests associations, and he who teaches literature succeeds to the extent that he can make his students feel. If I start with the dozens of associations which I can get right in class through the ear or the eye or the nose I have no trouble in getting my class to revel in literature. If I make them realize that the odor of freshly popped corn, the beauty of the falling snow, the countless sounds heard over the city, and the hundreds of feelings that they are having and are vitally interested in go to make up literature, I have a class who look upon literature as something vital, something a definite part of their own lives.

What about history?

Even more than my own subject it lends itself to the support of my second statement, for it has in it as a subject less of the emotional.

We are living in the present; we have lived in the past; we are hoping to live in the future. To me the matter seems so simple. We were placed in the world which is a law-governed world. We were given minds, and in common with the lower animals we were given feelings. Our study, then, is certainly laid out clearly enough for us. In proportion as we learn about laws we shall learn to appreciate the emotions through which our joys and sorrows come and to guide them so that our lives shall become more worth the living. In spite of the fact that we in retrospect long for the good old days, we know that as a result of our knowledge the humblest workingman of today is leading a fuller life than a king could have done a century ago. History should help us study the causes of the past which have led up to the effects of the present and so prepare us for the future. That it does not in all cases do so is no fault of the subject but in the way it is handled. History must be taught as a cause and effect subject. That will mean the throwing overboard of every superfluous fact; it will become applied history.

I might go on through the curriculum and name subject after subject; each has to meet the same test. It has to be applied. It has in some way to demonstrate that it can help the boy or girl become better able to think inductively and deductively and to enjoy more and more the sensations which were placed in the world to be enjoyed.

It seems altogether likely that we may here in the school of Engineering of Milwaukee succeed in working out something worth while along the lines of general science and along the lines of English, history and other subjects as well. This is a school of Electrical Engineering. It has more than 1500 students so that results gained by our experiments will have more value than if it were a much smaller school. All departments are working to the common end of making not mere electrical engineers but men who can think inductively and deductively and who can enjoy to the full the world of sights and sounds and tastes and smells and feelings in which they find themselves. As a teacher of English I think that the study of gen-

eral science before the student takes up his technical work in engineering will be a great help. More than that I think that each student coming to us would be able to do more accurate thinking now if he had from the time he was in the fourth grade been grounded in the fundamental laws of and on which the earth is based. In grammar, for example, had he learned to think instead of just to remember he would not come helplessly saying, "I have forgotten the parts of speech." Instead he would have the fundamentals of thought. With these he could unravel all the grammar anybody knows. Had he in history just learned a very few facts and applied them over and over again to solving the problems of every-day life, they would rebel as a group recently did when they found that they were supposed to take history. In brief, then, I may summarize by saying that general science should be given to every student in order that that student may learn to think inductively and deductively and that English, history and other subjects should contribute to the same end.

General Science Meeting

At a meeting of the GENERAL SCIENCE CLUB OF NEW ENGLAND held in Boston May 8, 1920, the following program was given.

To Determine the Percentage of Acidity of Vinegar Without a Knowledge of Molecular Weights. Herbert M. Thayer.

An Historical Background for the Study of Steam. Charles E. Stratton.

"Flame." Illustrated with about a dozen experiments. Charles H. Stone.

Demonstrations: Some Useful Pieces of Apparatus. 1. An illuminator to show slides for individual study. 2. Use of the Thorpe Gauge for comparison of gas consumption by different types of burners. 3. The Automatic Sprinkler in Action. Walter G. Whitman.

The Carbon Dioxide Fallacy. J. Richard Lunt.

Science Articles in Current Periodicals

ABRASIVES

The Story of Artificial Abrasives. Ill. R. F. Yates. Ev. Eng. Mag. 8:366-8. Mar. 1920.

ACHESON

Acheson: The Father of the Lubrication of the Future. C. H. Claudy. Sc. Am. 122:332. Mar. 27, 1920.

AERONAUTICS

What Europe is doing in Aviation. Ill. E. A. Dime. Sc. Am. 122:489. May 1, 1920.

The Airplane as a Commercial Possibility. Ill. D. W. Douglas. Sc. Am. Mo. 1: 339-343. Apr. 1920.

AGRICULTURE

Intelligent Use of Fertilizers. Gar. Mag. 31:104. Apr. 1920.

ASTRONOMY

Astronomy in Daily Life. G. B. Chase. Pop. Astr. 28:207. Apr. 1920.

A New Theory of the Deluge. H. P. Lee. Pop. Astr. 28:161. Mar. 1920.

AUTOMOBILE

Again the Steam Automobile. Sc. Am. 122:220. Feb. 28, 1920.

Why the Trailer Has Made Good. Ill. Howard Green. Sc. Am. 122:334. Mar. 27, 1920.

Improving Automobile Headlights. Ill. L. C. Porter. Sc. Am. Mo. 1:344-6. Apr. 1920.

Auto Headlight Regulation. Ill. Sharp and Little. Sc. Am. Mo. 1:347-350. Apr. 1920.

Systematic Lubrication and maintenance. Ill. V. M. Page. Ev. Eng. Mag. 9:14-16. Apr. 1920.

BASEBALL

What Makes a Baseball Curve. Ill. Lindley Pyle. Pop. Sc. Mo. 96:8:49. May 1920.

BILLBOARDS

Help to Abate the Billboard Nuisance. Am City. 22:276. Mar. 1920.

Tallahassee Chamber Rules Against Billboards. Am. City. 22: 405. Apr. 1920.

BIRDS

The Crow, Bird Citizen of Every Land. Ill. E. R. Kalmabach. Nat. Geog. Mag. 37:322-337. Apr. 1920.

CHEMISTRY

Chemical Warfare. A. A. Fries. Jo. Ind. and Eng. Chem. 12: 423-9. May 1920.

CITY PLANNING

Remaking a City by the Boulevard Route. Ill. W. T. Walsh. Ill. World. 23:265-268. Apr. 1920.

Creating millions for our Cities. Ill. Martin D. Stevens. Ill. World. 33:477-9. May 1920.

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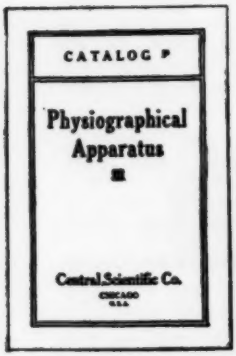

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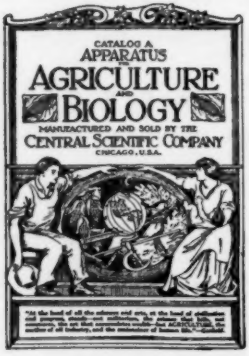

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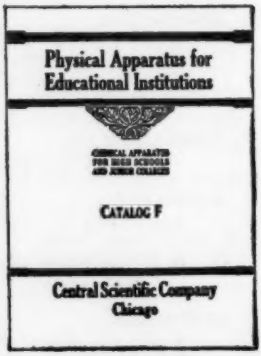

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No. 150 v. Cenco Friction-Drive Rotator.
No. 151 v. Boyle's Law Apparatus.
No. 152 v. Parker Glass Cutter.
No. 153 v. A New Molecular Demonstration Apparatus.
No. 154 v. Prepared Slides for the Microscope.
No. 155 v. A Lesson on the Transformer.
No. 156 v. Tungar Rectifiers.

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The Planning of a New Town. Ill. R. V. Black. Am. City. 22:283-6. Apr. 1920.
The Latest English Housing Planning Legislation. F. B. Williams. Am. City. (City Ed.) 22:364. Apr. 1920.

COTTON

Cotton Growing in South America. Ill. G. M. McBride. Geog. Rev. 9:35-50. Jan. 1920.
The Future of the Cotton Industry. H. E. Howe. Sc. Am. 122: 300. Mar. 20, 1920.

CLIMATE

Climate Cycles and Evolution. Ill. Griffith Taylor. Geog. Rev. 8:289-328. Dec. 1919.

DIAMONDS

The Diamond and Its Bloody Story. Ill. W. N. Burns. Pop. Sc. Mo. 96:3:37-9. Mar. 1920.
All about Diamonds. Ill. Joseph Kraus. Elec. Exper. 7:1115. Mar. 1920.

ENGINES

Development of the Internal Combustion Engine. T. B. Murray. Sc. Am. Mo. 1:350-6. Apr. 1920.
Steam Turbines and how they Work. Ill. R. F. Yates. Ev. Eng. Mag. 9:9-11. Apr. 1920.

FABRICS

Hairs that Make Fabrics. L. A. Hausman. Sc. Am. 122:184. Feb. 21, 1920.

FIELD GLASSES

Relative Merits of Monocular and Binocular Field-glasses. Ill. Edward P. Hyde and Com. Jo. Fr. Inst. 189:185-223 and 331-369. Feb. and Mar. 1920.

FIRE

Burning Millions. Rev. of Rev. 61:3:98. Mar. 1920.
Educate the Public and Reduce Fire Risks. Ill. W. A. McSwan. 22:131-3. Feb. 1920.
Fire Protection for Schools. H. W. Forster. Am. City. 22:37-42. Jan. 1920.
Fire Prevention as a Life Saver. J. R. Young. Am. City. 22: 260. Mar. 1920.
Our Daily Casualty List. Rev. of Rev. 61:4:120. Apr. 1920.

FISH

Ocean Rainbows. Ill. C. H. Townsend. Country Life. 38:1: 35-41. May 1920.

FOOD

Facts and Fallacies of Feeding. Cur. Opin. 68:355. Mar. 1920.
The Cause of Deterioration and Spoiling of Corn and Cornmeal. J. S. McHargue. Jo. Ind. & Eng. Chem. 12:257-262. Mar. 1920.

FORESTRY

Reclamation Work. Ill. R. S. Maddox. Am. For. 26:74-6. Feb. 1920.
Reforestation in Southwestern Penn. W. D. Ludwig. Am. City 22:143. Feb. 1920.

Flint on Steel

Fire is probably the most important scientific fact. The ancients worshipped it and moderns are dependent on it for all the arts and comforts of civilization. Here and there is a boy whose eyebrows are burned off because he made a fire the first independent project of his life—

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Forest Preservation in the Eastern Mountains. P. W. Ayres. Rev. of Rev. 61:411-5. Apr. 1920.
Winged Patrols for an Expansive Forest. Ill. R. F. Hammatt. Sc. Am. 122:387. Apr. 10, 1920.
Airplane Patrol of the Forests. Ill. F. A. Elliott. Am. For. 26:206-8. Apr. 1920.
Recreation in the Forests. Ill. A. H. Carhart. Am. For. 26: 268-272. May 1920.

FORMOSA

Formosa the Beautiful. Alice B. Kirjassoff. Nat. Geog. Mag. 37:247-292. Mar. 1920.

FLOODS

When the Father of Water Goes on a Rampage. Ill. Hugh M. Smith. Nat. Geog. Mag. 37:369-386. Apr. 1920.

FUEL

Motor Fuels. E. W. Dean. Jo. Fr. Inst. 189:269-302. Mar. 1919.

GARDEN

Painting the Landscape. Ill. Leonard Barron. Country Life 37:5:35-8. Mar. 1920.
Our Country and Our Gardens. Ill. C. G. LaFarge. Country Life. 37:6:35-8. Apr. 1920 and 38:1:42-46. May 1920.
Roses Remade for America. Ill. J. Horace McFarland. Garden Mag. 31:93-8. Apr. 1920.
The Hedge for Where You Live. E. J. Farrington. Garden Mag. 31:23. Mar. 1920.
Some Enemies of the Garden. Glenn W. Herrick. Nat. Study Rev. 16:113. Mar. 1920.

GASOLINE

Gasoline from Natural Gas. Harry Botsford Sc. Am. 122:359. Apr. 3, 1920.
Why is Gasoline High? Sc. Am. 122:415. Apr. 17, 1920.

HEALTH

Rating Restaurants. Am. City. 22:247. Mar. 1920.
On the Trail of the Yellow Fever Germ. Rev. of Rev. 61:386-392. Apr. 1920.
The Problem of Preventative Medicine. Cur. Opin. 68:506. Apr. 1920.
Home Nursing. L. A. Hewlett. Woman's Home Companion. 47:5:64. May 1920.

HYGIENE

Safe-guarding the Eyes of Workmen. Rev. of Rev. 61:214. Feb. 1920.
Unnecessary Fatigue. Frank B. Gilbreth. Sc. Am. Mo. 1:154-5. Feb. 1920.
Reclaiming a Polluted River. Ill. Jay Downer. Am. City (City Ed.) 22:13-17. Jan. 1920.
What the State Health Departments Do for the Municipalities. Am. City 20:49-53 and 138-142. Jan. and Feb. 1920.
Exterminating the Mosquito. C. C. Painter. Am. City 22:257. Mar. 1920.
Disinfection by Hot Air. Sc. Am. Mo. 1:211. Mar. 1920.
The Capillary Circulation. W. M. Bayliss. Sc. Am. Mo. 1:260-2. Mar. 1920.

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